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Standard Sizes of Periodicals and Catalogs.

Publishers and manufacturers alike are apt to forget that readers object to miscellaneous sizes of periodicals and catalogs whether filing cases, shelves or drawers are used for preserving the literature for reference. Whatever size or sizes are adopted as standards will therefore be frequently violated. It is easy enough to show that the publisher does much to defeat the purpose he has in mind by committing such violations, but he will nevertheless do it occasionally. Letters that we have recently published indicate that many of our readers have suffered from the nuisance of such violations. It is not however due, as some of them seem to think, to the fact that no one has thought of the advantages of standard sizes or that no movement has ever been made to secure such standards. The facts are exactly the opposite.

Some fifteen years ago, as the present writer well remembers and as many of our readers doubtless remember also, there was a wide spread agitation in the technical press and also among several at least of the engineering societies, for standard sizes of catalogs. The objections to and the annoyances from having catalogs of all sorts of sizes, the loss to the publishers from inability to conveniently file or shelve the trade literature received from him, and the various other phases of the subject were enlarged upon in many an editorial. This is worth recalling only because it resulted in something like authoritative action being taken in the matter of catalog sizes.

In 1893 the Master Car Builders' Association received and adopted a report of a special committee on standard sizes for catalogs and specifications. The sizes adopted were as follows: Postal card circulars $3\frac{3}{4} \times 6\frac{1}{2}$ ins.; pamphlets and trade catalogs $3\frac{1}{2} \times 6$ ins., 6×9 ins., and 9×12 ins.; specifications and letter paper $8\frac{3}{4} \times 10\frac{3}{4}$ ins. Later the American Railway Master Mechanics' Association, the American Society of Mechanical Engineers and various railway clubs and other engineering societies officially adopted the same standards. These standards are still in force in so far as such authority as has been stated endows them with any force.

Whether or not the sizes adopted above are the best solution that could be desired is open to question. Letters that we have recently published indicate that many of our readers favor a standard size of catalog measuring about $8\frac{1}{2} \times 10\frac{1}{2}$ ins., which is the ordinary size of letter paper. This size is conveniently filed in the vertical filing cases which have become so popular; and Mr. Emile Low, M. Am. Soc. C. E., points out the added advantage of being able to fold individual sheets of a catalog with any letter accompanying the sheets.

Unquestionably some standard size of catalog should be adopted and should be departed from only where exceptional rea-

sons exist. While the 6×9 , or book size, is today the most common size of catalog, we are inclined to agree with Mr. Low that an $8\frac{1}{2} \times 10\frac{1}{2}$ in. size is preferable unless the catalog is to be bound in cloth like a book.

As to the size of periodicals, there can be no question now that the 9×12 in. size is rapidly becoming standard for technical weekly publications, and there are indications that it will also become standard for monthlies. The publishers of Engineering Contracting adopted the 9×12 in. size because the majority of engineering periodicals were 9×12 in. Among the 9×12 in. publications may be mentioned the following: Engineering Contracting, Engineering and Mining Journal, Mining World, Mines and Minerals, Railroad Age Gazette, Electric Railway Journal, Roadmaster and Foreman, Power and The Engineer, American Machinist, Iron Age, Iron Trade Review, Concrete, Municipal Journal, Contractor, Construction News, Good Roads Magazine, American Architect, American Carpenter and Builder, Electrical Age, Electrical World, Marine Review, and others.

The arguments in favor of a standard size for technical periodicals are briefly these:

The advertiser should not be required to prepare cuts and copy for several different sizes of periodicals. To this end, also, it is advisable to adopt a two column advertising page for the 9×12 in. periodicals, except on pages devoted to advertisements requiring no illustrations, such as engineer's cards, wants, proposals, and the like. On those pages a three-column page seems preferable.

The reader finds it much more convenient to handle bound volumes not larger than 9×12 . Furthermore uniformity is desirable for filing the volumes in the shelves of a library.

Appreciating these facts, it is altogether likely that, within the next few years, practically every technical publisher will adopt the 9×12 in. size of periodical, excepting, possibly, the publishers of 7×10 in. monthly magazines.

Assessing Laborers for Medical Attention.

A subscriber calls our attention to an article in the Los Angeles Times of May 15, regarding the making of a contract between the Board of Public Works of that city and three physicians to care for the health of the men to be employed on the construction of the Owens River aqueduct.

The city agrees to build field hospitals at such points as the chief engineer may direct, and the contractors agree to equip each hospital with six beds and all medical supplies and place a male nurse permanently at each one. The city is to maintain the attendants of the medical department, in the same manner, as other

employees are maintained. The physicians agree to keep on the work a sufficient number of competent physicians and surgeons to give prompt aid to the sick and injured. For this service the physicians are to be recompensed by an assessment of \$1 a month upon every employee who receives \$40 or more per month, and 50 cts. upon every employee who earns less than this. As a laborer is paid in southern California from \$2.00 to \$2.50 per day, his monthly wage will be more than \$40, with the result that he will be assessed \$1.00 per month for medical attention.

It is contemplated that as soon as the construction work is well under way there will be about 4,000 men employed on the aqueduct, this would mean that the gross income to the doctors from the work for a year would be nearly \$50,000, which would mean an enormous net income from the work.

It is very true that in some sections of the country it is customary to deduct from a man's wages a certain amount for the "Doctor's bill," as the laborers term it, and frequently the employees themselves are anxious to have this done, but it is not right to charge an excessive amount, or so much that the laborer has a hardship put upon him, while the doctors are paid more than a fair compensation for their labor and expenditures.

The customary charge in contractor's camps and on railroads for men making \$100 per month or less is seldom over 50 cts. per month. With a small number of men the doctor's work is generally light and he is paid accordingly, and with a large number of men he receives a much larger amount. Even with the 50 cts. charge all the money should not go to the doctor. There are special expenditures to be made in some cases, and this relief fund will be called upon to meet such expenses.

The writer has had a good deal of experience in this connection and has had doctors employed to look after men on contract work under various agreements. He has found that the best plan is to pay the doctor a salary, based on a sliding scale of the number of men he has to look after. This pays the doctor for his work, and leaves some money to care for special expenses. The writer has found that 50 cts. per month per man will generally cover all of these expenses.

Many railroad companies who look after the health of their employees assess their men 50 cts. per month, unless they include in it some sick or death benefits, when the assessment is higher. The doctor in the employ of the railroad company is paid a salary.

A health insurance company that pays weekly benefits, we are informed, charges a premium of only \$6 per year, which is equal to 50 cts. per month.

It is evident from this that the Board of Public Works of Los Angeles, has made

a contract that will enrich some few physicians at the expense of its employees.

Some Good Examples of Educational and Drumming Advertisements in This Issue.

During the past few months we have had a series of articles on how to write effective advertising for engineering machines and products. The series of articles will be continued, but we pause to call attention to a few advertisements in *ENGINEERING CONTRACTING* that exemplify certain of the principles underlying successful advertising.

The "drumming ad" is well illustrated in several of our advertisements. One relates to concrete piles, and the advertiser sets forth in logical form the various reasons why corrugated concrete piles are superior. This advertiser also offers to give exclusive territorial rights to licensees, and in previous advertisements has used the educational form of advertising, showing the uses to which concrete piles in general can be put.

One concrete mixer firm is using the drumming form of advertising very effectively, while another is running a series of educational advertisements. An advertisement that attracts attention by virtue of its make up, and is convincing by virtue of its good drumming arguments, has been appearing for some time in our columns and relates to derricks.

A combined educational and drumming ad is that of one of the steam shovel firms.

A recent striking display ad shows a great variety of machines handled by one firm, each machine being illustrated by a small line drawing, and the advertisement itself being headed by a strong alliterative slogan.

Several advertisements contain extracts from catalogs, and may be classed under the head of "educational ads." One gives a diagram by which the percentages of different sized products from a rock crusher may be estimated. This is useful information and novel, thus forming an advertisement that is sure to attract attention, and will lead to many inquiries for the catalog that contains the diagram and full explanation of its use.

We might go on at considerable length calling attention to advertisements that are well written and well designed, and, in future issues we shall do so, believing it to be in the interest of advertisers to point to conspicuous examples of good advertising. We believe, also, that our readers will be greatly the gainers if more advertisers adopt up to date methods in advertising, for they will thus be put in touch with machines and products the full merits and uses of which had never before come to their attention.

Not a few of the advertisements offer business opportunities well worthy of serious investigation. New processes of road

and street building, new methods of trench and canal excavation, and new or improved machines for many other purposes, offer chances for wideawake contractors to take up profitable lines of special work.

We trust that, more and more, our advertising columns will lose the old fashioned directory form and adopt the "house organ" form of furnishing matter that is educative. Indeed, our desire is to have a large part of our advertising section become a "community house organ," which shall be noteworthy for the excellence of the information to be found there every week.

The Road Congress at Paris to Discuss the Destruction of Macadam by Automobiles.

An International Road Congress is to be held Oct. 11, at Paris. The macadam highways of France have been so badly damaged by automobiles that this Congress is called for the purpose of discussing methods of so constructing roads that they will hold up under the so-called sucking action of rubber tired vehicles moving at high rates of speed.

The Office of Public Roads has been conducting experiments near Washington, D. C., to ascertain the nature and extent of the damage to macadam were automobiles of varying weights pass over a macadam road at varying speeds. Instantaneous photographs were taken to show the action of the automobiles. When a racer was sent over the road at 60 miles an hour, press reports state that "it fairly lifted the road surfacing material as it sped along, regular ridges of rock dust rising in front of the rear wheels and floating away in blinding clouds."

Mr. L. W. Page, Director of the Office of Public Roads, and Dr. Allerton S. Cushman, Assistant Director, are conducting the tests, and will embody the results of their tests in a paper to be read at the Road Congress next fall.

A bill is to come before the Danish Government providing for the building of a bridge over the Masnedsund, between Zealand and Falster, to take the place of the present steam ferry. The cost of the bridge is estimated at about \$5,000,000.

The Belgian Royal Medical Society has been making an investigation as to whether the consumption of oysters has contributed to the apparent extension of typhoid fever. In summing up the professional testimony from different sections of the country the conclusion was reached that eating oysters could have been productive of typhoid fever only in exceptional cases, and in such cases was more to be attributed to the unsanitary manner in which the oysters had been handled than to any germs contained in the oysters themselves.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Examples of Labor Saving Machinery and Methods for Placing Con- crete Tunnel Lining.

With the increasing use of concrete for lining tunnels inventors have been busy with the devising of labor saving machinery and methods for improving the construction work. Traveling forms and

of 8 ft. radius, the arches being covered with a haunch filling of concrete and protected with a four ply water-proofing covering over the tops and down the sides to the springing line. In driving the tunnel the sequence of operation was such as to leave a large portion of the excavation to be removed by steam shovels. The left hand or west tube was carried about 400

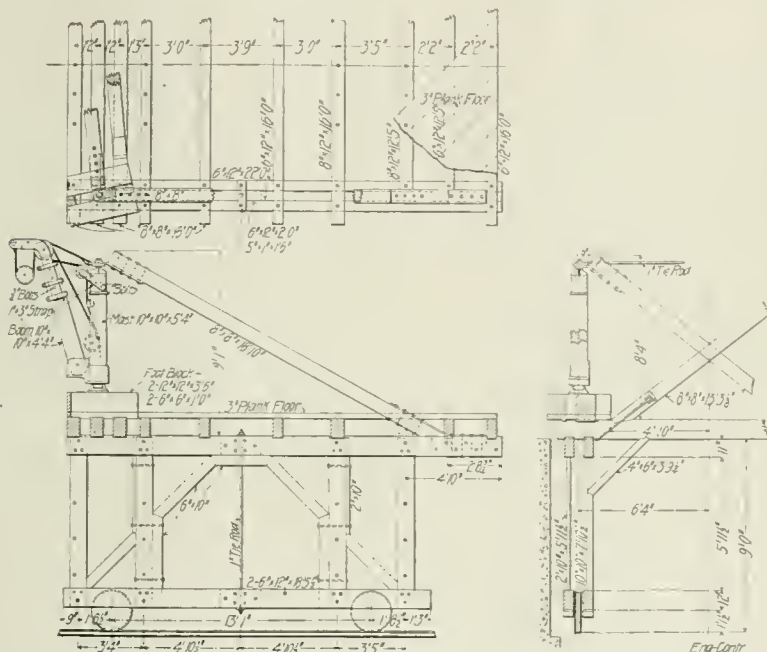


Fig. 1—Double Traveling Derrick for Tunnel Side Wall Construction.

mixing plants are being used and often mechanical devices for the more intricate tasks of transporting and placing the concrete. In the accompanying sketches we show a variety of such machinery and plant which has been developed in recent tunnel work. These devices have been designed under the direction of Mr. E. C. Williams and are controlled by the Tunnel Concrete Co., of New York City. The following description is from information furnished by Mr. Williams:

In the construction of the Pennsylvania R. R. Co.'s East First street tunnel, at Washington, D. C., the contractors, The New York Continental Jewell Filtration Company, had a contract which required the designing of considerable special machinery and new methods, on account of the section of the double tunnel, in order to complete the work economically and rapidly. The tunnel had twin tubes, the two tubes being separated by a 4 ft. sandstone wall, each with a 6 ft. side wall of concrete, and a five-ring brick arch roof

it. in advance of the other tube and the segmental timber arch of the right hand tunnel was supported at one end on the masonry of the left hand tunnel.

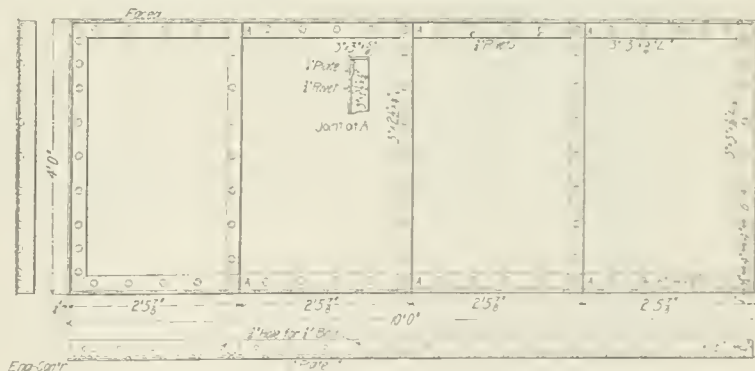


Fig. 2—Steel Plate Side Wall Form.

All the stone masonry and part of the concrete wall masonry in the entire driven portion of the tunnel were placed by small traveling derricks. Figure 1 is a detailed drawing of the double derrick

used in the left tube. In the right tube a similar machine was used with only one derrick for the construction of the other side wall. The operation of these derricks was the same as that of similar machines in the open, each derrick being driven by a 25 H. P. Lidgerwood electric hoist. The special features of these derricks were the curved iron supports for the end of the fall line and its return sheave on the end of the boom, which allowed the free swinging of the mast in the high position of the boom under the segmental arches and also gave the maximum lift of the load which, on the concrete side, was just sufficient to give 9 ins. clearance over the top of the forms for a 1 cu. yd. bucket, and the construction of the substructure, which allowed the free passage of all material trains, including 3 cu. yd. side dumping cars. These derricks were readily handled by one of the narrow gage electric mining locomotives used for hauling all material into the tunnel and the muck out. A cable was kept in position and so arranged that it only needed hooking on to the opposite side of the derrick frame, then onto the locomotive, when the entire structure would be moved forward or backward 30 or 40 ft., the operation requiring less than one minute.

The face forms for the side walls were steel plates 4 ft. x 10 ft. x $\frac{1}{4}$ in. reinforced with 3x3x5-16 in. angles (as shown by Fig. 2), down the sides and across the top and bottom, the length of the plate being divided into four panels by horizontal cross angles 3x2 $\frac{1}{2}$ x $\frac{1}{4}$ ins. Adjoining plates were bolted together every 6 ins. for their entire height. The bottoms and centers were lined by longitudinal 8x8 in. timbers, which were held in place by long bolts passing through the wall into the plumb posts. The tops were lined by a 4x4x $\frac{1}{2}$ in. angle bolted to the top angle of the forms and held in place by struts and tie rods carried back to the arch timbers. The top tie rods were used over, but the bottom and center rods were left in the concrete. The back

forms were of wood braced from the timbering, and were recovered before the space back of the wall was backfilled. In operation it required a gang of five men and a foreman one-half a day to take

car on the narrow gage track, laid at subgrade, hoisted it to the curved beam where the bucket was locked by the signal man; then bucket and hoist traveled up the beam to a position over the receiving^h hopper. Here the concrete was dumped into the hopper with the door closed, then the belt was started, the door in the bottom opened, and the concrete fed onto the belt, which carried it up the in-

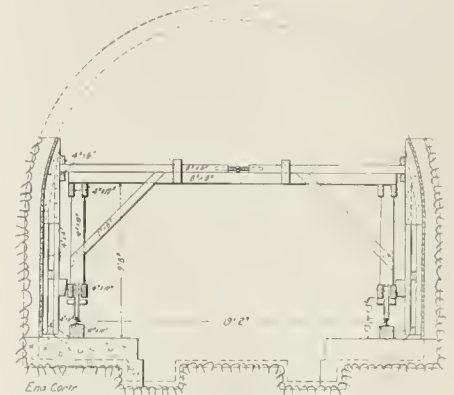


Fig. 7—Traveling Back Form to Fill Out Rock to Waterproofing Line.

ricks, a hoisting device, and a conveyor carried out on a centilever arm, adjusted to project over the arch ring or centering. Figure 4 is a detailed drawing of the

cline and out to the end of the arm, where it was deposited in the required position by swinging the arm from side to side of the tunnel, and moving the entire machine in and out. Besides the regular concrete gang of six men required to tamp the concrete in place, there were two men at the hopper, one man on the bottom to hook on the buckets, a hoisting engineer, and one man to clean the belts

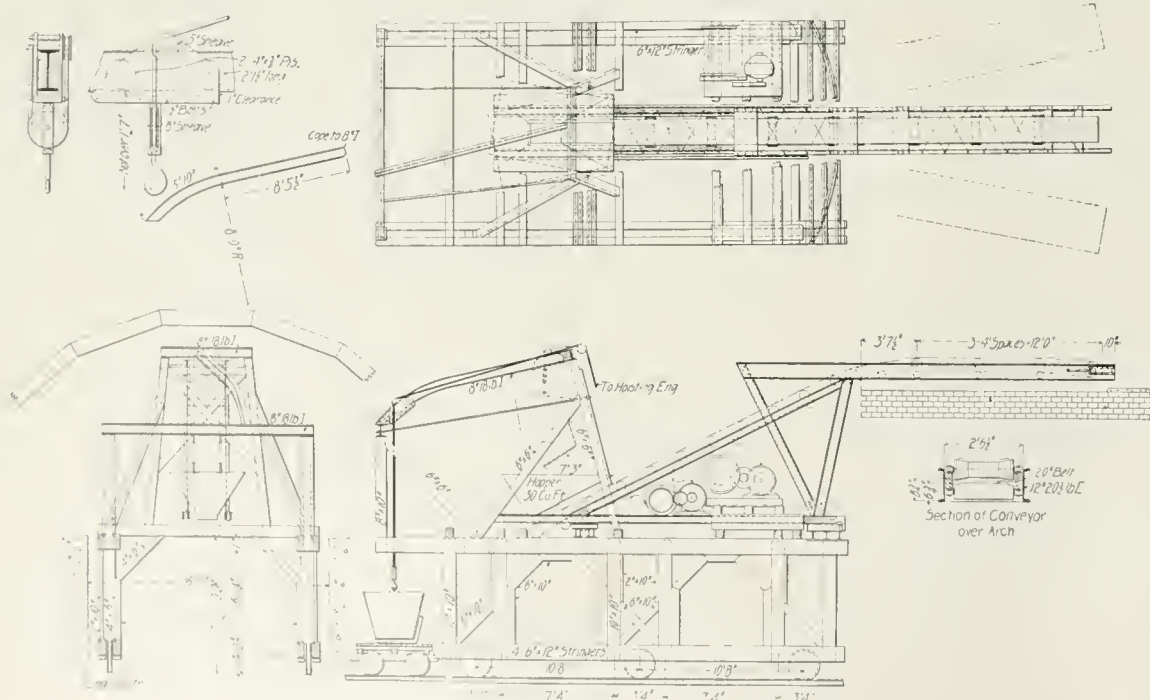


Fig. 4—Traveling Conveyor for Concrete Haunch Filling and Earth Back Filling.

and look after the machinery. The conveyor machine traveled on the same tracks as the derrick and centering, and was hauled by the electric locomotives the same as the derricks. These machines

were also used to place the earth or concrete backfill after the completion of the water-proofing. By the use of these machines, the ordinary working routine completed 60 lin. ft. of tunnel each week, and an average of 70 lin. ft. was maintained at times. The limiting factor was the delivery of the concrete from the mixer, and not the placing of it after being received,

with an arch of 15 ft. radius, where both the arch and side walls are of concrete. Figure 8 shows the proposed arrangement of a traveling side wall form. As shown, this is planned for sheet iron or wooden lagging, but heavier iron with angle iron reinforcement could be substituted. The plan provides for so bracing the forms as to leave the tunnel clear between the

of the conveyor machine moved in between opposite sections. The conveying device, in this case a belt, being mounted so as to swing 90° either side from the longitudinal position, the side wall concrete is placed from this belt and after the section has set, the operation is repeated until sufficient advance has been made to allow the starting of the arch work. With this arrangement, if for any reason work on one side wall had to be stopped, the other wall could be carried ahead, or more than one section of forms could be used, if necessary to increase the speed. After the side walls are sufficiently in the lead to allow the rapid progress of the arches, the rear portion of the machine is placed in position. It being possible to remove the bulkhead forms sooner than the arches could be struck, three sections of the arch forms would be used with each machine. With a section of the arch forms in position, the rear portion of the machine with its centilever arm projecting in over the centering, the forward portion would be brought back, connected to the rear portion and the 24-in. belt swung in position to feed the hopper of the 16-in. belt. As the placing of the concrete progressed, the centilever arm would take different positions over

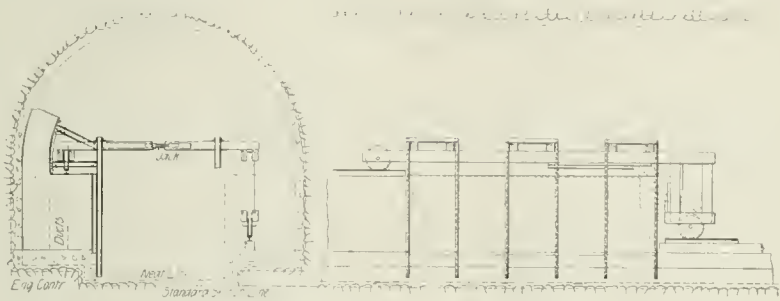


Fig. 5—Traveling Steel Side Wall Forms.

as high as 20 cu. yds. per hour having been maintained several times when the tracks were clear of other construction cars.

Instead of using the steel forms in separate sections, as at Washington, the contractors for the concrete work of the P. N. J. & N. Y. R. R. Company's tunnel through Bergen Hill, N. J., are using a set

inside faces. Figure 9 shows the proposed form of the conveyor machine, which is divided into two parts; the forward or driving portion carries the hoisting device, the main hopper, a 24-in. belt, or other conveying device, and a driving engine connected to the wheels of the substructure, and the rear of placing por-

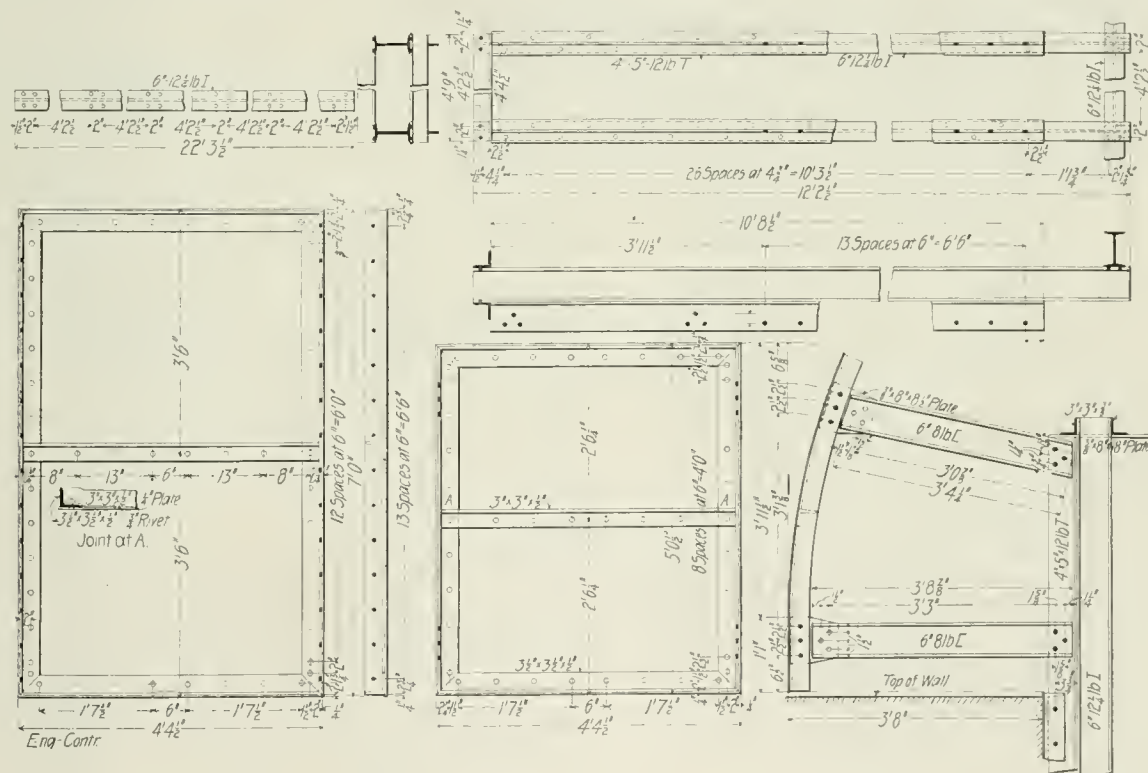


Fig. 6—Details of Steel Side Wall Forms Shown by Fig. 5.

of steel forms permanently bolted together and mounted upon a traveling frame, as shown in general side and sectional elevations by Fig. 5, and in detail by Fig. 6. Figure 7 is an end view of traveling back form used in the above tunnel, to fill out the rock to the water-proofing line.

Figures 9 and 10 show proposed forms and conveyor for a double track tunnel

tion carries the centilever arm, the cross drive and a raising and lowering device. Figure 10 shows the proposed arch forms; these, like the side wall forms, are provided for sheet iron or wood lagging, but could be changed to steel forms.

The sequence of operation of the above machines is as follows: The side wall forms are placed and the forward portion

the arch by a combination of the cross and vertical motions, as shown in the lower left hand sections of Fig. 9. The centering is provided with platforms for the concrete gang to work from. After an arch section is placed, the forward portion of the machine moves forward and places a section of side wall, then returns and places a second section of arch, then

The costs recorded do not include backfill, which was paid for under puddling, the trimming and finishing of exposed

France is making rapid progress in the manufacture of steel, having produced 2,677,805 metric tons of ingots in 1907 as compared with 2,436,322 metric tons in 1906 and 2,240,284 metric tons in 1905.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

A Contest of Different Makes of Pneumatic Hammer Drills.*

BY J. ORR.†

The contest was suggested by the South African Mining Journal which offered a trophy to cost at least \$500 as a prize. The conditions governing the tests were:

Drilling Time.—The trials are to commence promptly at 8:30 each morning. Each contestant shall do one hour's drilling in each of the three granite blocks A, B and C, and one hour's drilling shall be done in Block D, which shall be dry drilling. A pause of a quarter of an hour shall take place between leaving one block and column and starting on the next. During the three intermissions indicated nothing shall be done by the contestants to their machines other than to take them off one column and place them alongside of the next column. These four runs will represent a full four hours drilling shift, regardless of stoppages of any kind other than that caused by a drop in the air pressure. There shall be series of tests for each contestant, the first day's trials being at an air pressure of 50 lbs. and the second day's trials at an air pressure of 60 lbs. to the square inch.

Mounting Furnished.—Suitable columns, rigidly erected, will be furnished. Fastened to this arm will be a column or machine clamp, to be furnished by each contestant. The contestant may locate the columns in a suitable position for drilling operations before the trial begins, but must not adjust the arm or clamp, the nuts or wedges of which shall only be tight enough to prevent movement. The drill itself shall lie three feet away from the column, the chuck end facing the granite block to be drilled in. Each contestant is permitted to furnish his own column and column-arm if he so desires. The column must remain in a vertical position during drilling.

Angle of Holes.—The flat faces of the three granite blocks A, B and C, are set at an angle of 25° from the vertical. All holes in these blocks are to be drilled at right angles to these faces, i. e., at an angle of 25° below the horizontal. The flat face of the fourth granite block is set vertically. The first and third holes are to be drilled on the right hand side of the column, and are to be flat holes. The second hole is to be drilled on the left hand side of the column, at an angle of 10° above the horizontal, and the drill must remain at this an-

gle while starting the hole. These conditions will more or less represent stopping, sinking and driving.

Position of Holes.—At least one hole shall be drilled on each side of the column during each run on each block, each not less than 30 ins. in depth or more than 45 ins., and each hole shall require a change in the position of both the arm and the column clamp. Before the trial commences the location of the two or three holes to be drilled in each of the four faces is to be indicated by the judge.

Drilling to be done in Granite Blocks on the Robinson Mine.—The holes are to be drilled in four granite blocks, each block to be of uniform hardness throughout and rigidly supported.

Air Hose.—A 50 ft. length of 3/4-in. diameter air hose shall be employed during the trials, suitable couplings for each contestant's machine to be furnished by each contestant. The machine end of this hose shall be disconnected before the trial begins on each of the four granite blocks.

Working Space.—Each operator shall have a roped-in working space in front of the granite blocks of 8 ft. by 8 ft. at least.

Drill Steels.—While "South African Mines" will endeavor, and is ready to, furnish the ordinary solid steels required by each contestant for drilling purposes, so that no question may arise as to a variation in the quality of the steel used influencing the results obtained during the trials, it is desirable for each contestant to furnish his own drill steels—the majority of the contestants will probably prefer to do this.

Bits of Drill Steels.—Each man shall be allowed to take underground not more than 60 steels per day, and for surface work he shall not use an average of over 7 1/2 steels per hole. The starting bit may be any size that the contestant desires, but the finishing bit shall not be less than 1 1/4 in. for 26 in. holes, and 1 1/8 in. for holes over this depth. By this is meant that steels under 43 in. in length over all must have 1 1/4 in. diameter bits.

Type of Steels.—The bits used shall all be of the "star" or cross type. However, where the contestant wishes, he may use chisel bits if he prefers them instead of the "star" or cross type, so long as the diameter of the two last bits is not less than specified.

Extra Drill.—The provision of one extra drill is optional, although if used, special mention shall be made by the judges.

Position or Location of Steels.—Before stopping the holes shall be 36 to 45

ins. deep, with the exception of the last hole drilled, which may be less because unfinished at the stopping time.

Position or Location of Steels.—Before starting the day's trials the contestant may sort his steels and arrange them in sets close to the rock drills.

Number of Persons to a Drill.—There shall be only one person to each machine, to be furnished by the contestant, that person preferably to be a skilled white. No helper—white or black—is to assist the drill operator. In other words, the operator is to have no assistance whatever from either a helper, spectator, or the judge and his assistants.

Air Pressure.—A constant air pressure will be supplied, and a recording gage used to satisfy each contestant that the pressure under which he was working during the day was uniform throughout the run.

Water.—Water for clearing the hole being drilled, or allaying the dust caused by dry drilling, will be supplied. Contestant's stope drills which do not feed water through the machine, or employ a spray (not a jet), will be provided with one or more 5-gallon buckets of water. To such stope drills as feed water through the machine, or use sprays (not jets), water will be supplied through a water hose.

Time Allowances.—No allowance shall be made for any cause, other than failure in air pressure, it being assumed that the contestant shall have his two machines, steel bits, etc., in perfect order. So to secure bits properly tempered for the rock to be drilled in, each contestant may, a few days before the trials begin, test his bits on the granite blocks or stope the trials are to be made in. For rifled holes, bad steels, or time lost repairing breakages, no allowances will be made.

Work Done.—At the conclusion of each day's trial, the judge shall ascertain the footage drilled, and the time consumed, and inform us of the results, under the conditions outlined.

The Competitors.—The twelve competitors taking part in the 48 four to six-hour trials arranged for are as follows: "Kimber Drill," "Climax Little Wonder Tappet," "Grose," "Kid," "Climax Little Wonder Air Valve," "Holman," "Hardsocg Wonder," "Gordon," "Flottman," "Baby Ingersoll," "Cherisen," "Murphy." The sizes, weights, etc., of these drills, as well as the names of the manufacturers and agents, are given elsewhere.

The underground tests consisted in drilling 8 down holes, at the angle of the reef, on the first day, and 8 up holes also at the angle of the reef on the second day, both tests to be carried out at a constant air pressure of 60 lbs. per sq. in.

My duty as judge was simply to see that the machines were tested in strict accordance with the conditions. In connection with these conditions, I regret that no stipulation was made with regard to the measurement of air. It might also have

*Greatly condensed from the Journal of the Transvaal Institute of Mechanical Engineers.

†Professor, Transvaal University College, South Africa. Judge during the contest.

been more to the advantage of certain drills had higher air pressures been used. It was suggested by one member of the Advisory Committee that 40 lbs. rather than 50 lbs. was the average available pressure of air underground, but it is to be hoped that the days of such low pressures will soon be at an end; 50 lbs. air pressure was adopted for the first day's trial and the experience of the trials has shown that the second day's trial at 60 lbs. pressure was a wise step, as one result of the competition has been to conclusively establish the beneficial effect on footage drilled due to increased air pressures. Although my duties as judge in the competition are practically completed, my work in connection with the investigations of air consumption and air pressures is, I hope, only beginning. I intend at an early date to commence a series of experiments on various drills, in which the air consumption will be carefully ascertained and the effect of increase of air pressures to say 70, 80, 90 and 100 lbs., in relation to work done, accurately determined. There are many difficulties no doubt attending the measurement of the air used by a rock drill, but not unsurmountable in my opinion. Footage drilled was the deciding factor in the competition, but it was never anticipated, when the conditions were agreed upon, that certain drills with a diameter of cylinder little less than the ordinary development drill, would enter into competition with what was understood to be one-man stope drills. Later I give a table showing the relative piston displacements of the various drills, from which it will be readily admitted that the measurement of footage drilled without consideration of air consumed was by no means fair to certain competitors. I have not as yet considered the question of piston speed.

Little would be gained by discussing seriatim the conditions of the contest. Although dissatisfied with some of the details it is not for me to criticize conditions, laid down by a committee embracing the leaders of the mining industry and the engineering profession, and accepted by the representatives of the rock drill manufacturers. No doubt, with the experience gained, these could be improved upon in many ways. The horizontal and slightly upward-inclined holes proved too much for the ordinary percussion type of drill using solid steel, and the drilling speed in these holes was very low indeed with this type of drill. It was proved, however, that with hollow steel, using air or water, horizontal holes proved no obstacle in drilling, and no doubt the inclusion of these holes in the competition was of advantage in showing which class of machine was adapted for this work, typical for back stopping. Each competitor was allowed the use of a spare machine, but only one competitor completing the two days' run availed himself of the privilege of using the spare machine. A scheme, by which many of the observations not affecting the

award of the trophy may be taken into account, has been proposed by the "South African Mines" Journal. This scheme lays special stress on lightness, and facility of operation, which the competition has shown can best be obtained by drills of the hammer type. This allocation of points will be considered at a later date.

The site selected for these trials adjoined No. 2 shaft of the Robinson mine. Four granite blocks measuring approximately 5 ft. by 3 ft. by 3 ft. and weighing about 4 tons, were placed in position.

Blocks A, B and C were placed in the ground with the front lower edge on the surface and the front face inclined at an angle of 25° to the vertical. As previously decided by the advisory committee, each drill entered for the competition was required to drill one hour in each block. The holes drilled in Blocks A, B and C were to be wet holes drilled at right angles to the face. Dry holes were to be drilled in Block B, the first and third to be horizontal and on the right hand side of the column; the second hole on the left hand side to be drilled at an angle of 10° above the horizontal. These holes are always referred to by the drillers as dry holes, that is, holes into which water cannot be poured, but it was within the province of any competitor to supply water if his machine was specially designed to do so. No independent spray apparatus was, however, admitted.

The conditions laid down to govern the trials were rigidly carried out, and no allowances of any kind were asked for or made, as such would undoubtedly have led to complications invalidating the impartiality of my decisions. Air was taken from the second of the two receivers supplied from the compressor of the Robinson Gold Mining Co. adjoining, by means of a pipe 1½ ins. diameter to a small receiver about 50 ft. distant. A globe valve was inserted at the admission point to this receiver, a by-pass valve 1 in. in diameter enabling air to be exhausted from the receiver if any exceptional rise of pressure tended to take place, such as for example when one or both drills were stopped. This receiver was fitted with a relief valve 3 ins. diameter and on the top were inserted a Bristol pressure recorder and a pressure gage. This arrangement of supplying air at constant pressure was highly successful. The pressure gages were calibrated by myself on a deadweight gage tester prior to the trials, and the weighing machine was adjusted by the Assize Department of the Johannesburg Municipality. The air for supplying the two drills at work was drawn from the receiver through two independent ¾-in. pipes fitted with valves, and at the completion of each hour's run, the machines were stopped by rapidly closing these valves.

"Kimber" Hammer Drill.—The "Kimber" drill is of the hammer type with a diameter of cylinder 3½ ins., length of stroke 3 ins., length of feed 1 in., and a weight

of exactly 100 lbs. The hammer or striker is actuated without a valve on the differential piston principle, striking 800 to 1,000 blows per minute. The weight of the hammer is 12 lbs., in striking contrast to that of the "Gordon" drill, which weighs a little over 1 lb. The rotation of the drill steel is caused by a small cylinder cast on the front end of the main cylinder and on right angles to it. To the piston of this cylinder is attached a pawl, which engages with a ratchet wheel. This ratchet wheel has a square hole through the center to receive the chuck on which the blow is struck. The square part of this chuck is made a sliding fit and allowed to move longitudinally as the blows are struck, while the ratchet wheel gives the turning movement. The small piston is driven forward by means of air admitted to one end and governed by ports communicating with the main piston and driven backwards by a spring. The arrangement is such that for each blow, the drill steel makes 1-20th of a revolution. The cradle is cylindrical in shape, with a slot at the top side, which fits a lug cast on the cylinder and forming a slide. The feed is obtained by means of a screw and nut, with a crank handle attached in the ordinary way. The machine is simple in design with a few working parts, but it is at present only in the experimental stage, the machine competing having been the first built. Using hollow steel, this machine was more successful on the horizontal holes than any solid steel machine.

The percentage of actual drilling time to total time was low, being 57.8 per cent at 50 lbs. pressure, and 50.2 per cent at 60 lbs. pressure. The depth drilled per minute of total time was .63 in. and .85 in., at 50 and 60 lbs. pressure respectively. The figures for the depth drilled per minute of actual drilling time show considerable improvement, being 1.06 ins. at 50 lbs. pressure and 1.68 ins. at 60 lbs. pressure.

The depths drilled were 12 ft. 11¾ ins. at 50 lbs. pressure, and 16 ft. 11 ins. at 60 lbs., showing an increase at 60 lbs. pressure of 30.6 per cent. The total depth drilled was 29 ft. 10¾ ins. Several stoppages were made during the run for the purpose of oiling.

"Little Wonder" Air Tappet Drill.—This drill is of the reciprocating piston type, having a diameter of cylinder 2 ins., length of stroke 6 ins., length of feed 16 ins., and weight 118½ lbs. This drill is undoubtedly simple in construction, the tappet serving itself as a valve, thus reducing the number of working parts, the taper or rocker valve being operated direct by the piston, but, as in the case in all other form of tappet machines, it is open to the objection that it strikes a cushion blow, thus reducing the available force of the blow.

A feature of the drill is the adoption of the "Climax Imperial" drill method of taking air through the piston and hollow steel. A discharge of air takes place during the

back stroke of the piston, the object being to remove the cut particles of rock in the hole by blowing out, so as to present a clean face for the next blow of the machine. This arrangement makes this drill especially suitable for drilling dry holes, and it will be seen by reference to the accompanying table that this machine did its best work on the "dry" holes.

The "Gordon" Hammer Drill.—This machine (Fig. 1) entered for its trials on Tuesday, December 17. As in the case of the two previous drills, detailed results are given in the tabulated statement. This drill won the trophy, and, constituting as it does a radical departure from previous drills in use, it is perhaps well that I give a detailed description of it. It is far from my intention to even assist in advertising any drill, but where credit is due it should be unstintingly given, and the performance of the "Gordon" has called forth nothing but encomiums from the witnesses of the trials and the competitors alike. [This drill is manufactured by the Inger-

The advantages claimed by the makers for this type of drill are:

"Firstly.—The great reduction in the weight of the moving parts resulting in less loss of power and greater efficiency."

"Secondly.—Great reduction in weight, making it practical for one man or boy to handle and operate."

"Thirdly.—Strength and durability, due to all faces subjected to wear being of hardened steel."

"Fourthly.—Simplicity of construction and operation, making it possible for an unskilled person to do almost the same work as a skilled operator, as the machines drill equally fast regardless of the skill of the operator, the only difference being the time taken to adjust the machine and change the steels."

"Fifthly.—The machine drills equally fast on up, down, or flat holes, making it possible to replace the existing method of underhand stoping, by back-stoping, which has proved cheaper in other countries and will no doubt be found so here."

record the fact that not a particle of dust was to be seen, whether drilling on down, horizontal, or up holes. It has frequently been stated that with the hammer type of drill trouble is always experienced through the steels sticking in the holes. This certainly was so in the case of the "Kimber" and "Flottmann" hammer drills, but throughout the eight hours run which the "Gordon" made in no instance did this difficulty arise. Full particulars of the performance of this drill are set out in the tabular statement, upon which I need not dwell at length. I would, however, like to draw attention to the fact that the percentage of actual drilling time to total time was 87.7 per cent at 50 lbs. pressure and 86.4 per cent at 60 lbs. pressure. I regret that owing to the fact that no records are available, I am unable to compare these percentages with those obtaining underground. The footage drilled was 28 ft. 4½ ins. at 50 lbs. pressure and 35 ft. 9¼ ins. at 60 lbs. pressure, showing an increase of 29.5 per cent. It will also be

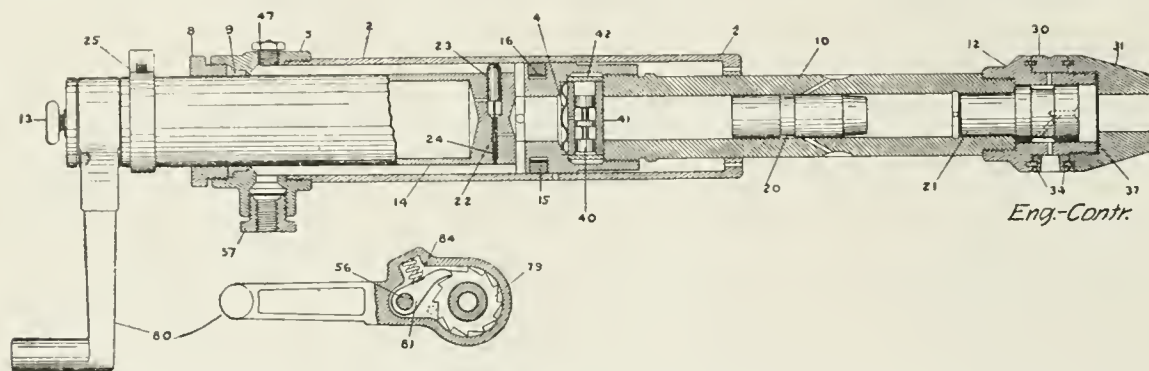


Fig. 1—Diagram of Gordon Hammer Drill.

2, Casing; 4, Screen; 5, Casing cap; 8, Casing cap gland; 9, Cup leather; 10, Cylinder; 12, Front head; 13, Oil plug; 14, Head block; 15, Head block ring; 16, Head block spring; 20, Piston; 21, Anvil block; 22, Oil stem; 23, Oil plunger; 24, Oil plunger spring; 25, Head block clamp and key; 30, Water ring; 31, Nose piece; 34, Water ring leathers; 37, Nose piece washers; 40, Valve; 41, Valve box; 42, Valve box sleeve; 47, Oil complete; 56, Rotating pawl rivet; 57, Inlet bushing and strainer; 79, Ratchet; 80, Crank handle; 81, Rotating pawl; 84, Rotating pawl spring.

soll-Rand Drill Co. of New York and is now being placed by them on the American market.—Editors.] The success of the Gordon drill has drawn attention to the hammer type, and it is interesting to consider in detail how a drill of this type, having a hammer weighing a little over a pound, has been made to do more work than the older type of machine, having pistons 20 to 30 times heavier, and piston displacements several times greater.

In this machine, as in others of similar type, the drill is fed forward automatically by the air pressure. Automatic rotation of the drill is not attempted, this being accomplished by the operator by means of a crank handle. It is claimed by the makers that the lack of uniformity of speed of rotation, due to this hand rotation, ensures that the number of rotations per minute will never remain an exact multiple of the number of blows struck sufficiently long to produce a rifled hole. The accompanying drawing (Fig. 1) has been reproduced with the object of enabling its action to be understood by any one who has not seen the drill.

"Sixthly.—The machine may be operated in any stope which is wide enough to permit the operator getting around in. This will mean stopes much narrower than are now carried and less waste of rock will be broken per ton of ore."

"Seventhly.—The machine is kept automatically oiled."

"Eightly.—The machine at all times delivers water to the bottom of the hole being drilled, thus increasing the speed of drilling, keeping the hole clear, and the bits free."

"Ninthly.—Last—and most important—is the fact that due to the water being fed through the bits the machine never produces any dust or resulting miner's phthisis."

In this machine, water being supplied through the hollow steel in addition to being directed towards the hole, by the exhaust air issuing round the shank of the steel, the allaying of the dust was perfect. The question of the allaying of dust being one of such vital importance with regard to the health of the miner, I wish here, as judge of the surface tests, to place on

noticed that the horizontal and vertically inclined holes, which proved such an obstacle with the majority of the other machines, were drilled with the same facility as the downward holes. It is also fair to point out that this drill accepted holes in the lower row of the blocks, which could not be drilled by the ordinary type of percussion machine. The Gordon drill used on the test weighed 72½ lbs., the diameter of the cylinder being 1 3/16 ins., the length of stroke 10 ins., and a possible length of feed of 20 ins.

"Little Kid" Drill.—The "Little Kid" rock drill is a small percussive machine, being in reality a copy, on a reduced scale, of the better known "Little Giant" drill. The diameter of the cylinder is 2 ins., the length of stroke 5 ins., the length of feed 18 ins., and the weight 102½ lbs. The makers claim that, in this drill, they have obtained the minimum weight without sacrificing strength and durability. The valve of the "Little Kid" drill is a plain slide valve which is thrown in the same direction as that in which the piston is moving,

A three-arm rocker gives a positive motion to the valve and enables a sharp cut-off and exhaust to be obtained at the desired point of the stroke, independent of the speed or air pressure. The machine is designed to run at pressures of from 50 to 100 lbs. The valve and valve seat have plain flat faces and are moved positively, the wear being automatically taken up.

"Hardsoeg Wonder" Hammer Drill.—This drill is of the hammer type, having a diameter of cylinder 1.8 ins., length of stroke 1½ ins., length of feed 18 ins., and a weight of 44¼ lbs., being the lightest machine entered for the competition.

The machine is held up to its work by air pressure, and the hammer, which weighs approximately 4 lbs., strikes the end of the bit at the rate of about 2,000 blows per minute, the idea being to affect the drilling by means of rapid light blows instead of comparatively heavy slow ones. The air-feed cylinder is fixed into a column arm bracket, the air entering at the air inlet through a rubber hose and, exerting a pressure on the air feed piston, pushes it forward. The piston being screwed into the end of the cylinder also moves forward and with it the drill steel.

The air, in addition to keeping the drill up to its work, passes through a hole bored through the length of the air feed cylinder into the hammer cylinder where it is used expansively. The machine is valveless and consequently the air is used expansively. The makers state that the best air pressure for this machine is 90 to 100 lbs. per square inch, and that pressures of 60 to 70 lbs. are too low for good work. A dust allayer is fitted to the drill, the hose being connected either to an ordinary water supply or to a tank placed in a position to give the necessary head.

After spending about three minutes in rigging up the machine, it was found impossible to get it to start. Since the trials, I have been told by the representatives that this was due to the hammer fitting too tightly into the cylinder. The spare machine was substituted and after an interval of 35 minutes from the starting signal actual drilling began. The diameter of the first steel used was 1½ ins., too heavy, in my opinion, for the machine, but no other was available. When the first hour was up a depth of only 3¾ ins. had been drilled.

"Baby Ingersoll" Drill.—The "Baby Ingersoll" is a percussive drill differing little from the general type, except in details of construction. The diameter of the cylinder is 2¼ ins., length of stroke 5 ins., the length of the feed 15 ins., and weight 120½ lbs.

It was the heaviest of the drills entered for the competition, and was well handled by the operator, although the makers do not pretend that it is a one-man drill. Like the "Little Kid," it is of the tappet type, the main difference being that the valve is

inverted, and the face instead of being flat, follows a curve of which the rocker pin is the center. This arrangement is, no doubt, a decided improvement, reducing the wear between the rocker arm and the valve. When not in operation, the valve is maintained against its seat by means of a small spring inserted in the end of the rocker arm. The valve acts on the ordinary D-valve principle, the air pressure keeping it tight against the curved face during operation.

The performance of this machine was quite good. It must not be lost sight of, however, that the diameter of the cylinder of this machine is 2¼ ins. as compared with the 2 ins. of the "Little Wonder," "Little Kid," and "Little Holman." Referring to the tabular results, it will be seen that, during the two runs of four hours each, a total depth of 54 ft. 9½ ins. was drilled. The depth drilled at 60 lbs. pressure was 29 ft. 6½ ins. as compared with 25 ft. 3 ins. at 50 lbs. pressure, an increase of 17 per cent. Here again, in common with machines of the same type, difficulty was experienced in drilling the "dry" holes. While for example at 60 lbs. air pressure the maximum depth drilled in 1 hour was 118¾ ins. on the wet holes, a depth of only 29¼ ins. was reached on the "dry" block D. This, of course, as in the other similar cases, reduced the average rate of drilling. In comparing results it must therefore not be forgotten that the solid steel percussive machines—the "Little Kid," "Little Holman," "Baby Ingersoll," and "Chersen" were seriously handicapped as compared with the "Little Wonder" and other hollow steel machines, through the inclusion of "dry holes" in the contest. No attempt was made to cope with the dust produced in drilling the "dry" holes; indeed this machine is not adapted for this work. The operator accepted a hole in the lowest and most inaccessible part of a block, the machine being mounted below the arm.

The "Flottmann" Hammer Drill.—This machine, like the Gordon, is of the hammer type, but differs in many essential respects. It has a diameter of cylinder of 2¾ ins., a length of stroke of 1¾ ins., a length of feed of 24 ins., and a weight of only 52¼ lbs. It is made entirely of forged steel, all the wearing parts being hardened and ground to gage.

Although very portable, this machine is very unwieldy owing to its great length, measuring as it does about 5 ft. long. This is to a certain extent due to the length of feed of 24 ins. which could with advantage be reduced to one-half as far as its use on the Rand is concerned.

"Little Holman" Drill.—The Little Holman drill is of the reciprocating piston type, having a cylinder 2 ins. diameter, a stroke of 5 ins., a length of feed 16 ins., and a weight of 97½ lbs. This is a neatly designed little machine, and is lighter than any of the other machines having the same diameter of cylinder. The valve is of the

piston or spool type controlled by patent steel ball auxiliary valves. The valve is therefore air thrown, differing in this respect from other percussive machines which ran in the contest.

The "Chersen" Drill.—This machine is of the percussion type with a cylinder 2¾ ins. diameter, thus ½ in. greater in diameter than the "Baby Ingersoll" and ¾ in. diameter greater than the "Little Wonder," "Little Kid," and "Holman," which are of the same type. This machine was expected to be a rapid driller—indeed it drilled a greater depth in the wet holes than any drill competing. Naturally its excellent performance was watched with considerable interest by the spectators, and with a certain amount of anxiety by the runners up for the trophy. As I have frequently pointed out in the case of solid steel machines, the progress of the "Chersen" was stopped by the "dry" holes. The fact that this machine was competing on equal terms with machines of less than half the diameter, demonstrates the necessity of air consumption being taken into account, and I hope, in any future competitions of this nature, that will be done. The "Chersen" is a neatly designed machine, carefully constructed, as will be understood from the fact that although 2¾ ins. diameter with a length of stroke of 6 ins. and length of feed of 18 ins., it weighs only 113½ lbs. It was excellently manipulated and worked without a hitch throughout the whole period of the trials. I regret to ascertain that trouble has arisen over patent rights in connection with this machine, and consequently I am unable to reproduce drawings and give a detailed description.

The performance on the various blocks is set forth in the tabular statement. The total depth drilled at 60 lbs. pressure was 33 ft. 2 ins., and at 50 lbs. pressure 26 ft. 3¾ ins., the total depth being 59 ft. 5¾ ins. The increase in footage due to increase of pressure from 50 to 60 lbs. was 26 per cent.

Summary.—I have prepared the accompanying summary of the performance of each drill taking part in the contest in order that comparisons may more readily be made. This summary gives the more important results obtained, and I prefer to let actual facts speak for themselves in this way rather than to indulge in cursory generalities. Before concluding, however, it may be expected of me to deal more or less briefly with several of the more important points which have arisen during the trials. In the passage which I quoted from the "S. A. Mines Journal" of Nov. 9, 1907, announcing the competition, and referring to the various stope drills offered to the mining industry, appears the statement: "It can also be safely assumed that all are one-man drills. There remains the question of the work each can do in a given time." The result of my observations during the contest has been to confirm my opinion that no drill exceeding

80 lbs. in weight can claim to be a one-man drill. Only three drills competing fell within this limit, viz., the "Gordon," 72⁵/₈ lbs., the "Flottmann," 52¹/₄ lbs., and the "Hardsocg," 44³/₄ lbs., and of these the representatives of the latter state definitely that the machine is not capable of doing good work at pressures so low as 60 to 70 lbs., but is intended for pressures of 90 to 100 lbs. It will be observed that the drills mentioned are all of the hammer type, the remaining hammer drill competing being the "Kimber," which weighs exactly 100 lbs. Of the reciprocating piston type, we have the "Holman," 97¹/₂ lbs.; the "Little Kid," 102¹/₄ lbs.; the "Chersen," 113⁵/₈ lbs.; the "Little Wonder," 118¹/₂ lbs.; and the "Baby Ingersoll," 129¹/₂ lbs. In justice to the entrants of these drills, it is only fair to remark that they do not claim that they are one-man machines. Whether it is possible economically to work stope drills which necessitate more than one man, and do not appear to offer any other striking advantages, such as increased footage drilled, I am not in a position to state. But the competition has demonstrated the existence of an admittedly one-man drill, capable of drilling in four hours at an air pressure of 60 lbs. over 6 ins. per lb. weight of machine. I regret that time does not permit of my analyzing the mass of data which I have collected. But the last line of the general summary is, I think, interesting, and instructive. Classified on this basis of inches drilled per lb. weight, the drills are placed in the following order:

Name of Machine.	Air Pressure.		Inches drilled per lb. weight of machine over drilling period of four hours.
	50 lbs. per sq. in.	60 lbs. per sq. in.	
"Gordon"	4.69	6.08	
"Flottmann"	4.33	5.83	
"Chersen"	2.79	3.50	
"Baby Ingersoll"	2.34	2.74	
"Little Kid"	1.85	2.63	
"Holman"	1.77	2.09	
"Little Wonder"	1.68	2.02	
"Kimber"	1.55	2.03	

From the above table one is forced to the conclusion that, for lightness combined with drilling capacity, the hammer type is essential. As I have already pointed out, it has frequently been urged against the hammer type, and insisted on strongly by certain competitors before the trials began, that the sticking of the steels in the holes was the fatal objection to the hammer type of drill. The "Gordon" drill has entirely disproved this statement, and has conclusively shown that if sticking occurs it is the fault of the operator. The records of the "Gordon" drill show the following holes to have been drilled:

Holes.	
On surface	21
Underground	16

By kaffir subsequent to contest.....12

Total 52
Requiring a total of 208 steels.

I have already on more than one occasion expressed my regret that the conditions of the contest did not provide for the measurement of air. This is a question which must be approached by the mining industry if, in the search for economy, the most suitable drill is to be selected. Certain rough observations were made during the trials, sufficient to indicate that there existed a wide diversity in the air consumption. For example, it was per-

can be made in drilling "dry" holes. This, I may mention, was strongly urged by the agents of certain machines, particularly the "Holman," who maintained that their drills were not intended for, and were not likely to be successful with, "dry" holes. The solid steel machines were the "Little Kid," "Baby Ingersoll," "Flottmann" (except on block D at 60 lbs. pressure), the "Holman," and the "Chersen," and the machines using hollow steel, the "Kimber" (air supply), "Little Wonder" (air supply), "Hardsocg" (water and air supply), and the "Gordon" (water and air supply). The latter machines had, as regards drill-

Table I.
Piston or hammer displacement per minute

Name of Drill.	at 50 lbs. pressure. cu. in.	at 60 lbs. pressure. cu. in.	at 50 lbs. pressure.	at 60 lbs. pressure.
"Gordon"	5,617	6,771	1.0	1.0
"Little Kid"	6,782	7,928	1.21	1.17
"Holman"	7,065	8,321	1.26	1.23
"Little Wonder"	8,460	9,964	1.56	1.47
"Flottmann"	10,395	12,166	1.85	1.78
"Baby Ingersoll"	10,945	12,736	1.95	1.88
"Chersen"	18,868	20,648	3.26	3.05

No. of strokes per minute of "Kimber" drill not ascertained.

fectly evident that the drill which takes second place was using at least 2¹/₂ times the air required by the winning drill. I have endeavored in the summary of results to give some indication as to the air used. The third last line gives the piston or hammer displacements in cubic inches per minute. Unfortunately no definite record of the strokes per minute was made, as such was not called for by the conditions; but I am indebted to Mr. J. A. Vaughan for the approximate figures which are given. On this basis we get Table I.

One doubtful factor, which must enter into every competition, where footage drilled is considered, is the quality and varying temper of the steels. Reference has been made to cases where the competitors were seriously handicapped through

ing in block D, a great advantage over the solid steel machines. The increase in drilling capacity due to the use of hollow steel is well illustrated in the case of the "Flottmann" drill, already referred to. Undoubtedly, one result of the competition will be the adoption of hollow steel, preferably with water feed.

But the question of hollow steel, supplied at the drilling point with water, has a significance reaching far beyond the mere question of rock drill economy. I refer to the prevention of miner's phthisis. I need not traverse or summarize what has been said on this subject; as I say, the mere question of obtaining increased profits, due to the adoption of stope drills, is one which sinks into insignificance if the lives of the drill operators are to be

Table II.

Name of Drill.	Depth drilled at 50 lbs. air pressure.	Depth drilled at 60 lbs. air pressure.	Percentage increase in depth drilled at 60 lbs. pressure.
"Kimber"	12' 11 ³ / ₈ "	16' 11"	36.6%
"Little Wonder"	16' 7 ⁷ / ₈ "	19' 11 ³ / ₈ "	19.7%
"Gordon"	28' 4 ⁵ / ₈ "	36' 9 ¹ / ₄ "	29.5%
"Little Kid"	15' 9 ³ / ₈ "	22' 6 ¹ / ₂ "	42.6%
"Baby Ingersoll"	25' 2"	29' 6 ¹ / ₂ "	17%
"Flottmann"	18' 19 ³ / ₈ "	25' 4 ³ / ₈ "	34.4%
"Little Holman"	14' 1 ¹ / ₄ "	17' 0 ¹ / ₄ "	18.6%
"Chersen"	26' 5 ³ / ₄ "	33' 2"	26.0%

Mean percentage increase.....27.3%

bad or badly tempered steels. I have purposely avoided mentioning the names of the firms supplying the steels; but this subject of steels is one which I hope to make experiments on at a future date, as the size and shape of bit, apart from the quality of steel, has been shown by the figures obtained in the contest to be one of great importance. The competition has to a great extent resolved itself into trials between the hammer type and reciprocating type of drills, and between hollow steel and solid steel, resulting decidedly in favor of the former. It has been conclusively shown that with solid steel no progress

sacrificed in the process. I have briefly referred to the production of dust under the heading of the various drills. It was perfectly satisfactorily demonstrated during the trials that solid steel machines, while successful on down holes, were equally unsuccessful as regards dust allaying on "dry" holes. Machines using hollow steel, fed with air, are simply dust creators, unless some effective means is made to cope with it. I have already referred to the spray dust allayer attached to the "Little Wonder" machine. When the spray is too fine the water is atomized, the method creating a damp atmosphere,

and receiving the condemnation of medical men owing to the likelihood of it being detrimental to the health of the operator. A water jet will not catch the dust, which can only be allayed with a proper spray. Here, as in so many other instances, it would appear that prevention is better than cure. The whole difficulty is solved by delivering water and air at the striking point. On this question no other conclusion can be arrived at either by the judge or by any one who visited the trials, and I need not reiterate what I have already said under the heading of the "Gordon" drill.

One important factor, to which attention has been directed during these trials, is the pressure of air which, for any particular drill, will give the maximum drilling speed. The results obtained at 50 and 60 lbs. pressure of air are before you, but these do not provide sufficient data, from which to draw many conclusions. It will be seen from Table II, which gives the footage at each pressure, and the percentage increase at 60 lbs., that the percentage varies from 17 per cent to 42.6 per cent, the mean percentage increase being 27.3 per cent.

Against the increase in work done must be placed the extra work required to compress the air to the higher pressure. The question of the most economical air pressure is a very important one, and I shall not enlarge on it here. A suitable air compressor being available, I hope, with the kind assistance of the Council of the University College, to shortly commence important research work in this direction.

The question of maintenance, to which I have not yet referred, is no doubt a most important one, but I deprecate unnecessary caution in accepting the results of the trials, owing to the fact that sufficient experience with the drills underground has not been had. As regards maintenance and durability, I should prefer to accept the maker's guarantee as the best criterion, and the competition has proved, after thorough public trials, the existence of several reliable stoppe drills. Too much is frequently made of the term "mining conditions" as a palliation of inefficient work and methods; too often, I am afraid, is the term synonymous with want of training, inexperience, incompetence and neglect.

Table III shows a sample of the record

kept for each hole the record being that of the Gordon Drill. Table IV (page 14) gives a general summary of the surface trials at 50 lbs. per square inch air pressure and at 60 lbs. per square inch air pressure.

A Correction.

In our issue of June 24, page 381, in describing the large clam-shell bucket, manufactured by The Hayward Co. for use at the plant of the Illinois Steel Co., a typographical error made us state that the distance between the jaws of the bucket, when open, was 1 ft. This distance should have been given as 11 ft., and the paragraph should have read:

"When closed the bucket is 12½ ft. high. It measures 7 ft. along the cutting edge of the bucket, and the distance between the jaws is 11 ft. when open. The power shaft is 5 ins. diameter, and the power wheel is 56 ins. in diameter. The nut on the power shaft alone weighs 40 lbs."

Of the 562,780 miles of railway in the world 258,957 miles are in America.

TABLE III.—SAMPLE OF RECORD KEPT FOR EACH DRILL FOR EACH HOLE.

"GORDON DRILL."

Results of Trials of Stopping Drills made at the Robinson Mine (No. 2 Shaft), on Tuesday and Wednesday, December 17 and 18, 1907.

Drill of Hammer Type. Diameter of Cylinder, 1 3/16 in. Length of Stroke, 10 in. Length of Feed, 10 in. Weight, 72½ lbs. Makers, Gordon Drill Co. Agents, Fraser and Chalmers, Ltd. Operator, F. Crean.

Trial No. 1 at 50 lbs. per sq. in. pressure of air.

Trial No. 2 at 60 lbs. per sq. in. pressure of air.

Block of granite drilled into.	A	B	C	D	Mean result Trial 1.	A	B	C	D	Mean result Trial 2.
1st HOLE.....No.	49	44	40	37	23	18	18	23	11	12.5s.
Time to fix arm in approx. position & tighten up	16s.	12s.	11s.	7s.	11.5s.	13s.	16s.	12s.	9s.	12.5s.
Time to place machine in position on clamp...	7s.	4s.	7s.	20s.	9.5s.	12s.	18s.	6s.	7s.	10.7s.
Time to put on air hose.....	5s.	7s.	8s.	8s.	7s.	10s.	6s.	21s.	6s.	10.7s.
Time to place steel in chuck.....	3s.	2s.	2s.	2s.	21s.	9s.	6s.	3s.	4s.	5.5s.
Time to adjust steel to required angle.....	46s.	11s.	38s.	1m. 37s.	4s.	30s.	18s.	1m. 9s.	2m. 8s.	1m. 1s.
Time taken to start machine after given signal	1m. 32s.	40s.	1m. 14s.	2m. 38s.	1m. 31s.	1m. 20s.	1m. 6s.	1m. 48s.	2m. 38s.	1m. 43s.
Diameter of starting bit.....	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"
Time of drilling with starting bit.....	22s.	1m. 12s.	22s.	43s.	41½s.	44s.	33s.	26s.	30s.	37½s.
Depth drilled with starting bit.....	First steel used for facing only.						First steel used for facing only.			
Time taken to change steel.....	5s.	2s.	3s.	7s.	34s.	2s.	14s.	6s.	3s.	61s.
Time elapsing between stopping and re-starting	29s.	5s.	9s.	6s.	12½s.	4s.	21s.	13s.	5s.	10.7s.
Diameter of first steel.....	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"
Time of drilling with first steel.....	5m. 16s.	4m. 26s.	4m. 36s.	4m. 49s.	4m. 46½s.	3m.	3m. 23s.	2m. 55s.	2m. 53s.	3ms. 3s.
Depth drilled with first steel.....	71"	61"	5"	77"	69-16"	51"	61"	51"	51"	51 15-16"
Rate of drilling with first steel—ins. per min.	1.35"	1.52"	1.09"	1.53"	1.77"	1.75"	1.99"	1.97"	2.04"	1.94"
Time taken to change steel.....	2s.	2s.	2s.	2s.	3s.	6s.	6s.	2s.	5s.	4.7s.
Time elapsing between stopping and re-starting	14s.	14s.	16s.	14s.	14.5s.	20s.	13s.	13s.	13s.	14.7s.
Diameter of second steel.....	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"
Time of drilling with second steel.....	7m. 40s.	5m. 44s.	6m. 14s.	5m. 21s.	6m. 14½s.	4m. 58s.	3m. 38s.	4m. 34s.	4m. 51s.	4m. 30s.
Depth drilled with second steel.....	61"	10"	10½"	82"	82"	91"	81"	84"	91"	81 15-16"
Rate of drilling with second steel—ins. per min.	.89"	1.74"	1.62"	1.57"	1.45"	1.94"	2.20"	1.86"	1.98"	1.99"
Time taken to change steel.....	10s.	8s.	13s.	13s.	11s.	4s.	10s.	7s.	6s.	6.7s.
Time elapsing between stopping and re-starting	23s.	34s.	31s.	31s.	29½s.	16s.	23s.	21s.	14s.	18.5s.
Diameter of third steel.....	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"
Time of drilling with third steel.....	7m. 3s.	5m. 22s.	6m. 14s.	6m. 36s.	6m. 18½s.	4m. 39s.	4m. 4s.	4m. 20s.	4m. 33s.	4m. 24s.
Depth drilled with third steel.....	11"	9½"	11½"	11½"	10½"	10½"	10"	9½"	10½"	10 5-16"
Rate of drilling with third steel—ins. per min.	1.56"	1.8"	1.8"	1.7"	1.71"	2.33"	2.43"	2.28"	2.3"	2.34"
Time taken to change steel.....	8s.	8s.	6s.	8s.	7.5s.	5s.	5s.	20s.	15s.	8.7s.
Time elapsing between stopping and re-starting	25s.	23s.	25s.	34s.	26½s.	14s.	22s.	20s.	32s.	26.7s.
Diameter of fourth steel.....	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"
Time of drilling with fourth steel.....	8m.	7m. 48s.	7m. 7s.	7m. 13s.	7m 32½s.	6m. 14s.	6m. 1s.	6m. 20s.	6m. 8s.	6m. 10.7s.
Depth drilled with fourth steel.....	15"	15½"	13½"	14½"	14"	16½"	15½"	16"	15½"	15½"
Rate of drilling with fourth steel—ins. per min.	1.87"	1.96"	1.93"	2.03"	1.93"	2.61"	2.61"	2.53"	2.51"	2.57"
Total depth of hole drilled.....	40"	41½"	40½"	41½"	40½"	42"	40½"	40½"	41½"	41 1-32"
Total time for hole.....	31m. 2s.	26m. 18s.	27m. 8s.	27m. 32s.	28m.	21m. 59s.	20m. 4s.	21m. 39s.	22m. 37s.	21m. 23s.
Total actual drilling time.....	28m. 22s.	24m. 32s.	24m. 33s.	24m. 48s.	25m. 33½s.	19m. 35s.	17m. 39s.	18m. 35s.	18m. 55s.	18m. 41s.
Percentage of actual drilling time is of total time	91.4%	93.3%	90.4%	91.2%	91.3%	89.1%	87.95%	85.8%	83.7%	86.6%
Depth drilled per min. of total time.....	1.29"	1.59"	1.48"	1.51"	1.47"	1.97"	2.0"	1.85"	1.83"	1.89"
Depth drilled per min. of actual drilling time...	1.4	1.7"	1.63"	1.68"	1.6"	2.14"	2.3"	2.16"	2.14"	2.2"
Total depth drilled in each block in 1 hour, total time allowed.....	78½"	91½"	87½"	82½"	340½"	108½"	118"	109½"	105½"	441½"
Total actual drilling time each block.....	53m. 27s.	54m. 50s.	51m. 44s.	50m. 30s.	210m. 31s.	52m. 34s.	51m. 55s.	53m. 12s.	49m. 43s.	207m. 24s.
Percentage actual drilling time is of total time each block.....	89.1%	91.3%	86.2%	84.1%	87.7%	87.6%	86.5%	88.6%	82.8%	86.4%
Depth drilled per min. total time each block...	1.31"	1.53"	1.45"	1.38"	1.42"	1.8"	1.96"	1.82"	1.76"	1.8"
Depth drilled per min. actual time each block...	1.47"	1.67"	1.69"	1.65"	1.62"	2.06"	2.27"	2.03"	2.13"	2.13"

Steels Used.—Rose bit for starter, 1½ in. diameter; same starter used for all holes during the day; all other steels have cross bits with a hole through them; water passes through hollow steels.

TABLE IV. "SOUTH AFRICAN MINES" STOP-DRILL COMPETITION. GENERAL SUMMARY OF SURFACE TRIALS.

Trial No. 1 at 50 lbs. per square inch air pressure									
	Kimber	Little Wonder.	Gordon.	Little Kid.	Baby Ingersoll.	Plottmann	Little Hoinan.	Chersen.	
Mean time to start drilling after signal	8m. 47s.	5m. 27s.	1m. 31s.	4m. 18s.	4m. 2s.	3m. 13s.	4m. 41s.	3m. 45s.	
diameter of first steel	11"	11"	11"	11"	11"	11"	11"	11"	
depth drilled with first steel	6' 1"	8' 9"	6' 9-16"	10' 1"	11' 1"	4' 0-16"	9' 1"	10' 1"	
time of drilling with first steel	7m. 18 2s.	8m. 58s.	4m. 46 1s.	13m. 38s.	8m. 24s.	6m. 16s.	11m. 18s.	7m. 38s.	
time elapsing between stopping & re-starting in changing steels	1m. 4 2s.	44 5s.	14 5s.	39s.	40s.	17s.	42s.	30s.	
diameter of second steel	11"	11"	11"	11"	11"	11"	11"	11"	
depth drilled with second steel	6' 0"	13' 1"	8' 1"	10' 1"	9' 1"	4' 5-16"	7' 9-16"	10' 1"	
time of drilling with second steel	5m. 36s.	2m. 8 2s.	6m. 14s.	9m. 46s.	6m. 54s.	2m. 32s.	10m. 43s.	7m. 35s.	
time elapsing between stopping & re-starting in changing steels	1m. 11 1s.	51 2s.	29 1s.	1m. 15s.	1m. 6s.	29s.	44s.	55s.	
diameter of third steel	5' 7"	12' 6"	10' 1"	7' 3-16"	8' 1"	5' 1"	10' 1"	13' 1"	
depth drilled with third steel	7m. 31 2s.	7m. 38 7s.	6m. 18 1s.	9m. 56s.	6m. 21s.	2m. 52s.	12m. 11s.	9m. 32s.	
time elapsing between stopping & re-starting in changing steels	1m. 52 2s.	46 7s.	26 9s.	2m. 9s.	1m. 20s.	1m. 2s.	36s.	49s.	
diameter of fourth steel	11"	11"	11"	11"	11"	11"	11"	11"	
depth drilled with fourth steel	6' 4"	8' 4"	14' 1"	12' 1"	10' 1"	10' 1"	10' 1"	8' 1"	
time of drilling with fourth steel	5m. 52 7s.	5m. 2s.	7m. 32 1s.	7m. 1s.	6m. 25s.	5m. 27s.	5m. 47s.	2m. 32s.	
time elapsing between stopping & re-starting in changing steels	2m. 43 5s.	11 1"	33s.	11 1"	5 1"	4m. 43s.			
diameter of fifth steel	7' 1"								
depth drilled with fifth steel	6m. 42s.								
time elapsing between stopping & re-starting in changing steels	2m. 42s.								
diameter of sixth steel	5' 3"								
depth drilled with sixth steel	3m. 36s.								
time elapsing between stopping & re-starting in changing steels	2m. 18s.								
diameter of seventh steel	11"								
depth drilled with seventh steel	2m. 57s.								
time of drilling with seventh steel									
Total depth drilled in Block A	2' 11 1"	3' 11 1"	6' 6 1"	4' 4 1"	7' 1 1"	5' 5 1"	4' 2 1"	7' 10"	
Total depth drilled in Block B	3' 11 1"	4' 5 1"	7' 7 1"	4' 9 1"	7' 11 1"	6' 0 1"	4' 5 1"	8' 8 1"	
Total depth drilled in Block C	3' 4 1"	4' 0 1"	7' 3 1"	4' 5 1"	7' 5 1"	6' 3 1"	4' 2 1"	7' 5 1"	
Total depth drilled in Block D	3' 6 1"	4' 2 1"	6' 10 1"	2' 7 1"	2' 7 1"	1' 0 1"	1' 5 1"	2' 5 1"	
Total depth drilled in four hours total time	12' 11 1"	16' 7 1"	28' 4 1"	15' 9 1"	25' 3 1"	18' 10 1"	14' 4 1"	26' 5 1"	
Percentage actual drilling time is of total time	57.8%	71.1%	87.7%	79.5%	76.7%	60.7%	79.9%	75.3%	
Depth drilled per minute of total time	6.3"	8.3"	1.42"	1.22"	1.22"	.94"	.71"	1.33"	
Depth drilled per minute of actual running time	1.06"	1.17"	1.62"	1.01"	1.69"	1.43"	.93"	1.33"	
Diameter of cylinder of drill	3 1"	2 1"	1 3-16"	2 1"	2 1"	2 1"	2 1"	2 1"	
Length of stroke	3"	6"	10"	5"	5"	11"	5"	6"	
Approximate number of strokes per minute		450	506	432	550	1,350	450	530	
Displacement of piston or hammer—cu. in.	23	18.8	11.1	15.7	19.9	7.7	15.7	35.6	
Approximate displacement of piston or hammer per min.—cu. in.		4,860	5,617	6,782	10,945	10,395	7,065	18,868	
Weight of drill—in lbs.	100	118 1"	72 1"	102 1"	129 1"	52 1"	97 1"	113 1"	
Inches drilled per lb. weight of machine in four hours	1.55"	1.68"	4.69"	1.85"	2.34"	4.33"	1.77"	2.79"	

Trial No. 2 at 60 lbs. per square inch air pressure.

1st Hole.									
Mean time to start drilling after signal	5m. 25s.	7m. 40 7s.	1m. 43s.	3m. 51s.	3m. 28s.	4m. 59s.	3m. 9s.	2m. 56s.	
diameter of first steel	11"	11"	11"	11"	11"	11"	11"	11"	
depth drilled with first steel	10"	6' 7"	5' 15-16"	8' 1"	8' 1"	4' 1"	7' 9-16"	5' 11-16"	
time of drilling with first steel	8m. 8s.	9m. 54s.	3m. 38s.	6m. 23s.	4m. 42s.	4m. 47s.	8m. 18s.	4m. 8s.	
time elapsing between stopping & re-starting in changing steels	58s.	42 5s.	14 7s.	57s.	33s.	12s.	27s.	27s.	
diameter of second steel	5' 3-36"	17 1"	8' 15-16"	8' 1"	8' 5-16"	6' 3-16"	9' 1"	1' 9-16"	
depth drilled with second steel	4m. 12s.	12m. 2s.	4m. 30s.	6m. 17s.	3m. 44s.	3m. 23s.	8m. 58s.	4m. 20s.	
time of drilling with second steel	1m. 34s.	50 5s.	18 5s.	55s.	51s.	15s.	47s.	44s.	
time elapsing between stopping & re-starting in changing steels	1m. 11 1s.	11 1"	11 1"	11 1"	11 1"	11 1"	11 1"	11 1"	
diameter of third steel	8 1"	9 1"	10' 5-16"	10' 1"	8' 1"	5' 1-16"	10' 1"	10' 5-16"	
depth drilled with third steel	5m. 7s.	5m. 15s.	4m. 24s.	7m. 29s.	4m. 14s.	4m. 8s.	6m. 58s.	4m. 40s.	
time of drilling with third steel	1m. 42s.	1m. 16s.	26 7s.	1m. 0s.	1m. 26s.	1m. 57s.	39s.	45s.	
time elapsing between stopping & re-starting in changing steels	11 1"	11 1"	11 1"	11 1"	11 1"	11 1"	11 1"	11 1"	
diameter of fourth steel	6 1"	11 6"	15 1"	11 3-16"	10' 1"	13"	10' 1"	10' 1"	
depth drilled with fourth steel	2m. 58s.	3m. 51s.	6m. 10 7s.	7m. 45s.	8m. 58s.	5m. 11s.	7m. 15s.	4m. 58s.	
time of drilling with fourth steel	2m. 52s.				1m. 30s.	33s.	53s.	59s.	
time elapsing between stopping & re-starting in changing steels	4m. 49s.				6m. 37s.	5m. 17s.	10m. 23s.	10m. 23s.	
diameter of fifth steel	11 1"				3"	9' 1-16"	4 1"	7 1"	
depth drilled with fifth steel									
time of drilling with fifth steel									
time elapsing between stopping & re-starting in changing steels									
diameter of sixth steel									
depth drilled with sixth steel									
time of drilling with sixth steel									
time elapsing between stopping & re-starting in changing steels									
diameter of seventh steel									
depth drilled with seventh steel									
time of drilling with seventh steel									
Total depth drilled in Block A	3' 10 1"	4' 2 1"	9' 0 1"	6' 8 1"	8' 8 1"	7' 6 1"	4' 8 1"	9' 5 1"	
Total depth drilled in Block B	4' 9"	4' 6 1"	9' 10"	6' 8 1"	9' 10 1"	4' 10 1"	5' 2 1"	11' 1 1"	
Total depth drilled in Block C	3' 5 1"	4' 7 1"	9' 1 1"	6' 10"	8' 6 1"	6' 10 1"	5' 1 1"	11' 1 1"	
Total depth drilled in Block D	4' 10 1"	6' 6 1"	8' 9 1"	2' 2 1"	2' 5 1"	6' 0 1"	1' 11 1"	2' 8 1"	
Total depth drilled in four hours total time	16' 11 1"	19' 11 1"	36' 9 1"	22' 6 1"	26' 6 1"	25' 4 1"	17' 0 1"	33' 2 1"	
Percentage actual drilling time is of total time	50.2%	67.0%	86.4%	77.1%	71.3%	70.6%	81.4%	77.1%	
Depth drilled per minute of total time	.85"	.99"	1.8"	1.12"	1.47"	1.27"	.85"	1.66"	
Depth drilled per minute of actual running time	1.68"	1.41"	2.13"	1.46"	2.11"	1.79"	1.06"	2.22"	
Diameter of cylinder of drill									
Length of stroke									
Approximate number of strokes per minute		530	610	505	640	1,580	530	580	
Displacement of piston or hammer—cu. in.									
Approximate displacement of piston or hammer per min.—cu. in.		9,964	6,771	7,928	12,736	12,166	8,321	20,648	
Weight of drill—in lbs.									
Inches drilled per lb. weight of machine in four hours	2.03"	2.02"	6.08"	2.63"	2.74"	5.83"	2.09"	3.50"	

The United States Civil Service Commission announces an examination on July 22, 23, 24, 1908, to secure eligibles from which to make certification to fill one or more vacancies in the position of electrical engineer and mechanical draftsman, at an entrance salary from \$100 to \$200 per

month, in the Reclamation Service, and vacancies requiring similar qualifications as they may occur. Eligibles from this examination may be appointed as electrical engineers or assistants for the design, installation or operation of hydro-electric and steam power plants in the west, or as me-

chanical draftsmen for office work and drafting in connection with the preparation of plans. The examination will consist of the following subjects: Mathematics, applied mechanics, mechanics of materials; hydraulics; theory and practice of electrical engineering, etc.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Method and Cost of Using Calcium Chloride as a Dust Preventative.

During the summer of 1907, the U. S. Office of Public Roads, undertook a series of tests to determine the value of calcium chloride as a dust preventative. These tests were made on the portion of the macadam driveway in the Agricultural Department Grounds, in Washington, D. C., which connects 12th and 14th Sts. The results obtained were set forth in a circular issued by the U. S. Department of Agriculture and the matter in this article has been taken from that circular.

The roadway on which the test was made is built of trap rock, held in position by a soft limestone binder. The screenings of this binder pulverized rapidly under traffic, forming a light dust which passing vehicles continually raised into the air. It was then carried away by the wind. In this way the road was becoming stripped of its binding material.

In preparation for the treatment all dust, and dirt were scraped from the surface of the roadway. A solution was prepared by mixing 300 lbs. of commercial calcium chloride (granular, containing 75 per cent calcium chloride and 25 per cent moisture) with 300 gallons of water in an ordinary street sprinkler, care being taken to agitate the liquid thoroughly before applying it to insure a uniform solution. It was then applied from one sprinkling head, and the sprinkler passed slowly back and forth over the road to facilitate the complete absorption of the solution. Each application consisted of 600 gallons over an area of 1,582 sq. yds., or 0.38 gallon per square yard.

The first application was made July 13, 1907, followed by a similar one July 15, to increase the efficacy of the treatment. The effect of the first two treatments was marked. No auxiliary sprinkling was necessary for some time, the light rains falling at intervals supplying all the moisture required. The untreated portions of the driveway lying parallel to 12th and 14th Sts. were sprinkled daily and vehicles raised a perceptible dust, although the traffic over these wings was much less heavy than that on the treated portions.

During this time the appearance of the roadway varied perceptibly in color according to the moisture in the road surface, ranging from a light gray when dry to a peculiar grayish brown when moist. The brown shades were deepest over the portions traversed by the wheels of vehicles. The texture of the road surface was completely changed after the applica-

tion of the calcium chloride. Before treatment, raveling was excessive in spots and the whole surface seemed loosely knit together. After the application on July 15 this condition changed and the road surface became smooth, compact, and resilient.

The third treatment was given Aug. 3, as certain points exposed to the most severe wear were showing signs of raveling. The phenomena following this treatment were not unlike those attending the first set of applications and repeated themselves as later applications were made, though no further treatments were given until the condition of the roadway seemed to demand it. Such auxiliary sprinkling as was necessary consisted in the application of about 0.2 gallon of water per square yard at a time.

The accompanying table shows the cost of applications. The calcium was donated by a manufacturing chemical company of Baltimore, Md., and is charged at the rate of \$16 per ton, f. o. b. cars at Baltimore. A freight charge of 13 cts. per hundred-weight is added to place the material on the ground. This makes the total cost of the calcium chloride \$18.60 per ton.

	Per	Total.	sq. yd.
600 lbs. calcium chloride...	\$5.586	\$0.00352	
3 men, 1½ hours.....	.675	.00042	
1 horse sprinkling wagon,			
1½ hours	.525	.00033	
Total (1,582 sq. yds.)...	\$6.786	\$0.00427	
Total cost of five applications was \$33.90,			
or \$0.0235 per square yard. Labor was			
paid 15 cts. per hour and 35 cts. per hour			
was paid for the sprinkling wagon.			

The specific gravity of these solutions ranged from 1.053 to 1.060. Some variation was unavoidable, as the calcium chloride in some of the barrels had absorbed a large amount of moisture from the atmosphere. In such cases the actual percentage of the chemical to 300 pounds was less than where little or no moisture had been absorbed.

At the time of the last application several hundred pounds of the salt remained unused. This was divided as nearly as possible into two parts, to be applied to the two wings of the driveway lying parallel to 12th and 14th Sts. The east wing received a treatment of 0.28 gallon per square yard of a solution the specific gravity of which was 1.145 and the west wing a similar application of a solution having a specific gravity of 1.121. No further sprinkling was found necessary for the remainder of the season upon these branches of the main driveway.

Methods of Using a Road Grader on Hills.

The grading of roads in hilly, stony places is difficult work, and many road officials hesitate to undertake it with a road grader. In the Proceedings of the Iowa Good Roads Association, Mr. J. H. McMillen, describes his method of doing this work as follows:

"In places where I have to work away from a high bank so that I cannot get the dirt with four horses abreast I use three teams in line, but if I have plenty of room I prefer eight horses two fours abreast. I use an equalizer of my own make and whether I use four, six or eight horses one man does the driving as one can drive much better than two or more.

"Where there is rock that I cannot work out with the grader I have them either picked out or blasted with dynamite so that I can work them and then if I can't get dirt enough from the sides to cover them and they are not a thin shelly rock that can be easily hammered fine and left in the road I draw dirt from the hill above to cover it and then smooth it with the grader after which it is kept in this fine shape with a V drag. On a hilly road I work the grader just as hard as possible when going down hill and go empty up hill; I have three reasons for this:

"First. It greatly reduces the grade of the hill because a grader carries the dirt farther forward than it does toward the center of the road.

"Second. On account of the attraction of gravity in going down hill the dirt will roll away from the blade with but very little resistance and you have the weight of grader, men and horses to help it along, while in working up hill you are carrying the dirt against the blade and it will not work off nearly as well on account of the weight of the grader and men, together with the extra exertion of the horses in climbing you cannot gather much dirt and what you do get is deposited in the wrong place.

"Third. I find that by working down hill and going empty up hill, I can work all the time and build a longer piece of road in a day than those who try to work both up and down hill.

"In grading on a hill where the water has washed out a big ditch on each side, instead of starting out at the ditch, as nearly all road men do, and working the loose dirt and rubbish into the center to be washed away with the first rain, or left soft and full of ruts, I commence in the center and work the loose dirt across the road into the ditches, thus reducing the grade of the hill, filling up the ditches, and leaving the road as smooth and hard as a dirt road can be. If the ditch is on one side only, I commence at the other side and carry all the loose dirt across the road into the ditch. A road worked in this way in the spring will be a hard, smooth road all summer."

A Molding Machine for Building Cement Sidewalks.

We illustrate herewith a machine that lays and finishes cement sidewalks with remarkable rapidity. It consists of a traveling mold and of a winch for pulling the mold ahead. The concrete for the base of the sidewalk is shoveled or dumped into the front part of the mold, and the finishing mortar is shoveled or dumped into the hopper at the middle of the mold. This hopper is so designed that it feeds a thin layer of mortar onto the concrete base as the mold travels forward. Thus a complete and perfect sidewalk is delivered at the rear end of the machine.

No skilled finishers are required. No labor is needed to build forms. No men are needed to tamp the concrete. In brief, the process is simply one of mixing the ingredients and depositing them in the proper part of the traveling mold. The mold does the rest.

With a properly organized gang, the

is still green, it can be cut with a wire into any desired lengths.

The inventor of this machine is Mr. Ernest L. Ransome, and the manufacturers and owners are the Ransome International Conduit Co., 11 Broadway, New York.

The Cost of Applying Tarvia and Screenings to a Road.*

The county of Camden, with the help of your road department, has made some extensive and expensive experiments with oil and tarvia. Our road committee, together with its engineer, visited some tarvia coated roads in Pennsylvania, and were led to believe the experiment would be worth a trial, particularly along the White Horse turnpike road, the famous automobile route between Philadelphia and Atlantic City. This seemed to be the appropriate place to expend the funds derived from the automobile license fund, therefore our experiments were confined almost entirely to this one road. As is well known, the funds col-

riages move noiselessly as over a first class asphalt pavement, and with about the same amount of damage to the road surface. There is no abrasion and but little dust.

We applied the tarvia hot, using a furnace or kettle built for the purpose on wheels. We first sent a gang of men ahead with stable brooms and swept the stones as clean as possible, then dragged the kettle behind a wagon. The kettle was provided with a gate valve and a short piece of hose, through which the hot tarvia was distributed over the cleaned stone surface, then brushed out evenly with stable brooms. We then applied the screenings, to make an absorbent. In a few hours the road was ready for use. We made our first experiments in last May and continued them during the summer, using several carloads of tarvia.

For those wishing to use tarvia, we would recommend, first, to have the road in good order, free from dust, and well crowned. Under all other conditions our experiments were unsatisfactory. I would apply tarvia on a hot, dry day. Use plenty of good trap rock screenings, and results promise to be most gratifying. Rain and windstorms have no effect on roads so treated.

We had previously made some experiments in 1905 with crude petroleum, and the objections about balanced the good results. In August, 1906, we applied one carload of heavy oil from Texas, at 12 cts. per gallon. Counting the labor of applying oil, it cost us about \$125 per mile, on a 14 ft. wide stone bed. As a dust absorbent it acted like magic, but its results were not lasting. It is a question in the minds of some whether we cannot make more frequent applications of oil and attain almost as good results, and with a more moderate expenditure than is required with tarvia.

By another year we hope to be able to speak more positively as to the values of road coatings and dust preventatives.

Postmaster-General Meyer has appointed a committee of postal experts to investigate the feasibility of Government purchase, installation of equipment and maintenance of pneumatic tube service and the approximate cost of the same.

A bill has been passed by the Danish Government providing for the construction of several new railways in that country. The latter comprise the doubling of the line through Fuenen, five state railways, including a line from Copenhagen to Kjoerge, which will considerably shorten the international route via Gjedser, and 51 private railways, concessions for four of which may be granted annually. The expenditure to be incurred by the state treasury is estimated at about \$15,000,000 spread over 16 years.



Machine for Laying Cement Sidewalk.

mold is kept traveling continuously at the rate of 2 ft. per minute. The shape of the mold is such that the concrete is squeezed both laterally and vertically into a dense block, which, as above stated, required no ramming.

Perhaps the most remarkable feature of the mold is the perfect finish that it gives to the sidewalk. The walk looks as if it had been hand finished with floats.

While this device is intended primarily to build sidewalks in place, it may be used to build slabs of concrete which may be taken up and laid like flagstones.

It has been asked whether a perfectly smooth sidewalk can be laid on any kind of ground in this manner. The answer is that it has been done without any trouble. Nor do steep grades offer the slightest difficulty to the successful operation of the mold.

It is believed that this sort of a mold can be used for making cement lintels, coping, fence posts, railway cross-ties and a multitude of concrete structures having a uniform cross-section: for, while the concrete

lected from automobile licenses are distributed by you for the purpose of repairing roads already built. Camden county took a large share of its allotment in tarvia. We might have bought the crude coal tar and treated it ourselves by driving off the water and ammonia with heat. The cost of tarvia was but little more, so we took the product claimed to be specially prepared for the purpose. We applied it in various places under different conditions and with varying degrees of success. On a stone bed, 14 ft. wide, we used 60 bbls. per mile.

The tarvia cost 6¼ cts. per gallon and 0.4 ct. per gallon for freight. We used 100 tons of trap rock screenings per mile as an absorbent for the tarvia, which cost about \$175, and \$80 for labor, or a total cost of about \$450 per mile. This seems like a heavy outlay, but where conditions were favorable, and road in good order, resurfaced and well crowned, the results so far have been satisfactory. There has been no wear of the stone. Wagons and car-

*Abstracted from a report by John J. Albertson, County Engineer of Camden County, N. J., to the State Commissioner of Public Roads.

Killing Weeds Along Country Roads.

The subject of weeds along country roads is one of importance, inasmuch as the weeds of farms are caused in part by the roadside weeds being allowed to go to seed. Many states have recognized this fact and have laws dealing with the extermination of weeds along the roadside. In the Manual of the Iowa Highway Commission, methods of destroying various kinds of weeds are given. In that state the rag weeds and thistles are common, and the squirrel-tail grass is also becoming very abundant.

The squirrel-tail grass is an annual or winter annual, appearing abundantly in the fall. To prevent its seeding in the meadow, grass should be cut early. In this way blue grass will have a chance to grow and it will not be necessary to plow up the roadside if the grass is cut in this way for a few years.

The mustards may be exterminated by treatment with copper sulphate solution. This is made by the use of one pound of copper sulphate to four gallons of water; 50 gallons should be used to the acre.

The horse nettle as well as the thistles are perennials and hence it is more difficult to exterminate them. The following method for extermination of the Canada Thistle may be applied to this class of weeds:

The only method of treatment is to cut down and remove all of the "roots" as far as it is possible to do so. If done frequently and thoroughly the weed can be removed. If the patch is a small one, cutting off the parts below the ground several inches as soon as they appear above the ground several times during the season, will certainly destroy it. In large patches plow the ground, harrow and remove the thistle, either burn the material or put into compost heaps. This should be done five or six times during the season as occasion may require.

The best mode of exterminating the horse nettle is to smother the plants. This is probably the most effective and least expensive method of removing this plant. For this purpose clover is the most suitable plant. The soil should be harrowed or cultivated frequently until the time of seeding, which may be any time during May and June. Planting to corn or oats is a method also used in destroying the horse nettle. The plant should be kept down before seeding time. The removal of the nettle when in a well advanced stage, but before the production of seed (as when cut, with clover or early cereals) is often resorted to, the idea being to kill the plant by shock. This method is simply an effective means of preventing the production of seed.

Dock, which is a common weed everywhere along roadsides, can be exterminated as follows: The most efficient means of destroying this weed is to root it out by hand and this is done very readily in the

spring when the soil is wet by taking hold of the plant just at the surface of the ground, giving the root a slight twist and at the same time an upward pull, and the root will readily come from the soil. Where it is common, however, it is sometimes plowed or a spud is used. This method is not, however, so efficient as the pulling method.

Tar Macadam on Concrete Foundation.

A departure from the usual practice in the under construction of tar macadam work at Ottawa, Ont., was made by that city in paving the roadway of Elgin st. The foundation on this street for the tar macadam was made of concrete instead of spalls as has been the practice heretofore, the construction being as follows:

The roadway was excavated to the required subgrade and a 6-in. foundation course of concrete was then laid, particular care being taken to see that the concrete was well tamped under the base of the 80-lb. 7-in. steel rails of a street railway track which occupied part of the street. One row of Nepean sandstone stretches was then laid outside of each rail and a single row of sandstone headers beveled to fit under the head of the rail, along the inside of each rail and bedded on a 1-in. cushion coat of sand. These sets were grouted with cement mortar, and the space between the stone and the rail carefully filled with mortar. The open space between the rails and in the devil strip was then filled up to within a little more than 1½ ins. of the top of the rail with 2-in. tarred limestone. On top of this was laid the wearing coat of ¾-in. tarred limestone and well rolled. The remaining space between the track allowance and the combined curb and gutter was laid with the 1½-in. wearing coat of ¾-in. tarred limestone on the top of the concrete foundation. The whole was then dusted with fine limestone, well brushed in and given a final rolling. Another innovation was in connection with the underground drainage work in the construction of the gullies in concrete in place of brick in cement. It was found that these concrete gullies in concrete in place of brick in a cheaper rate than the other type. The work was done in 1907, and as far as could be judged at the end of the season, the pavement appeared to be in excellent condition. The aggregate for the most part was supplied by the city, while the tar and bitumen mixture was supplied by contract. The work was done by day labor, the average cost of the pavement being \$2.50 per sq. yd.

A government bill has been introduced in the Mexican Congress providing for subsidies to the extent of \$25,000,000 (Mexican dollar equals 49.8 cents) to irrigation enterprises to be paid from special yearly appropriations.

Data on Macadam and Gravel Road Work.

The following data have been furnished us by Mr. A. W. Saunders, Johnstown, Pa., who was in charge of the work. The contract called for a macadam road in a northern Michigan city, the stone to be paid for by the yard on the cars. The road was 4,400 ft. long and was macadamized to a full width of 30 ft. In addition there was a strip down the sides for about 4,000 ft. The road had a fine sandy soil which absorbed water like a sponge. The 6-ton steam roller was unable to run on the subgrade. A total of 4,310 cu. yds. of stone was used in the work.

Teams were paid \$4.50 per day, and made 11 loads per day on a 6,000 ft. haul, each load containing 1.8 cu. yds. The average load of the cars was 35.5 cu. yds., and it cost \$3 per car to unload them. The freight was \$8 per car and switching cost \$2 per car. The stone cost \$0.60 per cubic yard for all grades.

The spreading gang consisted of four men at \$1.75 per day of 10 hours, and two men at \$3 per day, the latter being a superintendent and a foreman. The steam roller engineman was paid \$2.50 per day of 10 hours, and the roller consumed one ton of coal in three days. The cost of oil, waste and water amounted to about \$1.25 per week, and an allowance of \$3 was made on the job for depreciation and repairs.

The cost per cubic yard, all stone being measured on board cars, was as follows:

	Per cu. yd.
Stone	\$0.600
Freight and switching	.282
Unloading	.085
Teaming	.227
Superintendence and spreading.....	.091

Total (measured loose).....\$1.275

The water and fuel used averaged about .1 ct. per cubic yard, and depreciation also amounted to about .1 ct. per cubic yard. The rolling cost 2.7 cts. per cubic yard.

The following data relate to a gravel road, 25 ft. wide. The gravel was often very wet, puddled in fact. 87 cu. yds. of gravel made 90 lin. ft. of street 6 ins. thick on the center line and 4 ins. thick at the gutter. The gravel was unloaded from a lighter, 10 men doing the work. Six men in a 10-hour day loaded 124 cu. yds. on six teams, using eight wagons. Each round trip of team averaged 45 minutes, a total of 68 trips being made in a 10-hour day.

The cost per cubic yard measured loose was as follows:

	Per cu. yd.
Gravel	\$0.850
Unloading	.150
Hauling	.257
Spreading	.087
Superintendence and depreciation..	.021

Total

Water-works and Sewer Section

Note: This section is devoted to methods and costs of constructing sewers and water-works. It will cover the construction work for all details of water supply and sewerage, including sewage purification and water filtration.

Methods of Constructing a Large Reinforced Concrete Sewer, Using Steel Centers, at St. Louis, Mo.

The first section of the Harlem Creek sewer, St. Louis, Mo., 29 ft. wide and 18.62 ft. high, interior dimensions, was described in our issue of Feb. 20, 1907, with an analysis of the cost of the work. The accompanying engravings show the con-

struction is kept considerably in advance of the concrete work and as new material is taken out it is carried back by cableway and used for backfilling. About 8 ft. of good solid rock is encountered in the trench and at the present time it is being blasted small enough to be shoveled into the cableway buckets, when it is transported to the tail tower, dropped into a hopper, and loaded onto 40 cu. ft. Koppel cars which carry it

to a crusher and it is then used in the concrete.

The mixing plant, consisting of crusher, sand bin, and mixer, is located permanently at about the center of the job. The cars reach it by a gravity road which is 800 ft. from the cableway. The mixing plant consists of a No. 33 Chicago Improved Cube concrete mixer, with charging elevator, one No. 3 Gates crusher, one sand elevator, etc. The entire equipment is run by electric motors and the contractors claim this is the most economical method they have yet used.

The concrete, after having been mixed, is dumped in 34 cu. ft. bottom dump buckets loaded onto flat Koppel cars and carried by gravity to the tail tower of the cableway from where it is carried to the position needed. The sewer is heavily reinforced with corrugated bars, furnished by the Expanded Metal & Corrugated Bar Co., St. Louis.

The method used in the construction of the sewer is as follows: After the excavation is alined to grade, the lower part of the invert is laid in place, the invert bars placed, and the concrete continued to the springline. One ring of brick for the invert is then put on. For the crown, the contractor has 50 ft. of Blaw collapsible steel centers. These centers consist of main right and left trusses to which the steel plates are bolted. The truss ends are then connected by adjustable braces used for both collapsing and reinforcing purposes. After the steel forms are set the crown reinforcement is put in place and the whole crown is concreted at one time.

For finishing the ends of sections a steel bulkhead was manufactured and is answering the purpose admirably. The center is used in 25 ft. units; it is moved forward

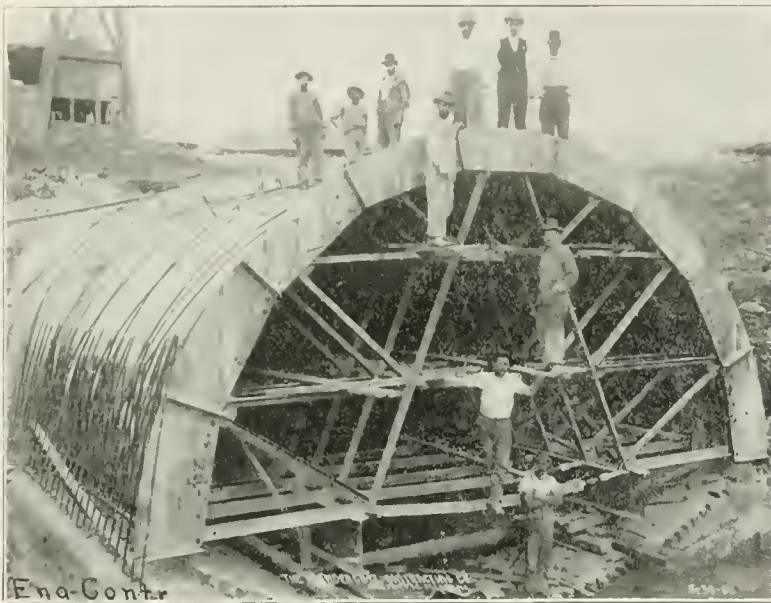


Fig. 1—View Showing Steel Center at Harlem Creek Sewer.

tinuation of the work on the reduced section 25 x 17 ft., inside dimensions. For the larger section wood centers were used; for the present work a steel center of the Blaw collapsible type has been substituted, as is shown by the view Fig. 1. The following is a brief description of the present work:

The second section of the Harlem Creek sewer is about 3,000 ft. long, the concrete is 14 ins. thick at the crown and 26 in. thick at the springline, and the invert is composed of concrete 12 ins. thick which is covered with one layer of vitrified brick. The concrete mixture for the arch is 1-2-5, and for the invert is 1-3-6, St. Louis Red Ring Portland cement being used throughout.

The excavation averages 33 ft. wide and 25 to 51 ft. in depth and is handled by industrial railway and cableways. A $1\frac{1}{4}$ cu. yd. Little Giant Shovel (Fig. 2) is used for the soft material, dumping this material into 36 cu. ft. tubs hung on the Lambert cableway of 500 ft. span. The excava-



Fig. 2—View Showing Work of Excavation in Progress.

on tracks and has a wheel attachment to facilitate this moving. When the center is put in position it is jacked up from the track 4 ins. and when ready for moving it is lowered to the track, moved forward by four men, and has been collapsed, moved forward, and set up in new position by the above mentioned number of men in exactly two hours. When the center is collapsed it leaves the concrete smooth and needs absolutely no refinishing.

The entire plant equipment on this work is as follows: 50 ft. Blaw collapsible steel centers; two Lambert 500 ft. span cableways; one Little Giant traction shovel; twelve 40 cu. ft. double side steel Koppel cars; six 46 cu. ft. double side steel Koppel cars; twelve flat cars and buckets; four thousand feet (4,000 ft.) single track; one No. 33 Chicago Improved cube concrete mixer with charging elevator; one No. 3 Gates crusher; one sand elevator; one Alberger horizontal centrifugal pump 2½ in. suction; various motors for crushers, sand hoist, mixer, pump, etc.

For the information from which this description has been prepared we are indebted to the Blaw Collapsible Steel Centering Co., Pittsburg, Pa.

Water Hammer Tests.

The following is abstracted from a paper on "Experiments on Various Types of Fire Hydrants," by Charles E. Newcomb, that appeared in the Journal of the New England Water Works Association. In *ENGINEERING-CONTRACTING*, June 24, page 382, was printed the test of the hydrants, and this reprint deals with the water hammer, caused by quickly closing the main gate.

To get some measure of the water hammer effect, caused when a hydrant is quickly shut down, the following apparatus was devised:

An indicator was attached to the connection in the 6-in. hydrant inlet which had been used by the U tubes. The drum of this indicator was operated by clock work, and was so adjusted as to revolve once in from three and a half to four minutes.

A small weight and cord kept the pencil in contact with the paper during the taking of a card.

Two lines of hose were taken from the hydrant under test to the meter nozzle, and the hydrant gate opened wide. A 1¼-in. nozzle was used and the pressure set at about 43 lbs. by adjusting the gate on the inlet pipe at the entrance to the building. This gave a discharge of approximately 600 gals. per min., which was considered a fair rate of flow for these tests.

At a given signal the indicator cock was opened, the clock-work set in motion, and time taken. After running steadily for about one-fourth of a minute the hydrant valve was quickly closed; that is, it was closed as quickly as an active man could close it, using an ordinary hydrant wrench. As soon as steady conditions were re-

stored, the valve was as quickly opened again. This was repeated two to three times during the time that drum of indicator was in motion. Any variation of pressure caused by this closing or opening of the valve was recorded on the card. The time occupied in closing, and also in opening, was taken by a stop-watch, so that some comparison can be made between the treatment given any one hydrant and another. Sample cards from the various tests have been picked out, grouped, and directly reproduced in Fig. 1. In getting this reproduction the delicate lines made by the pencil point of the indicator were carefully gone over with ink so as to get a card which could be photographed.

This method of measuring cannot show just what the actual pounds rise of pressure in any particular case would be, as this depends on the arrangement of piping supplying the hydrant, and the drafts of water in the system independent of the hy-

gain a few seconds of time at the risk of crippling the distributing system, very likely at the critical point of a fire.

In several of the compression hydrants a vibrating effect will be noticed during the opening of the valve. This is apparently due to a chattering of the valve, and produces a rather undesirable water hammer, as it is a series of quick, sharp flows.

Reducing the Cost of Coal in the Boiler Room of a Water Works.*

WALTER L. WATSON.

The writer has during the past ten months been scrutinizing most carefully the results obtained at one of his pumping stations. For some reason the impression has been particularly strong that there was a possibility of great improvement in the boiler room results.

This plant consists of one 100 h. p. Vulcan Iron Works horizontal tubular

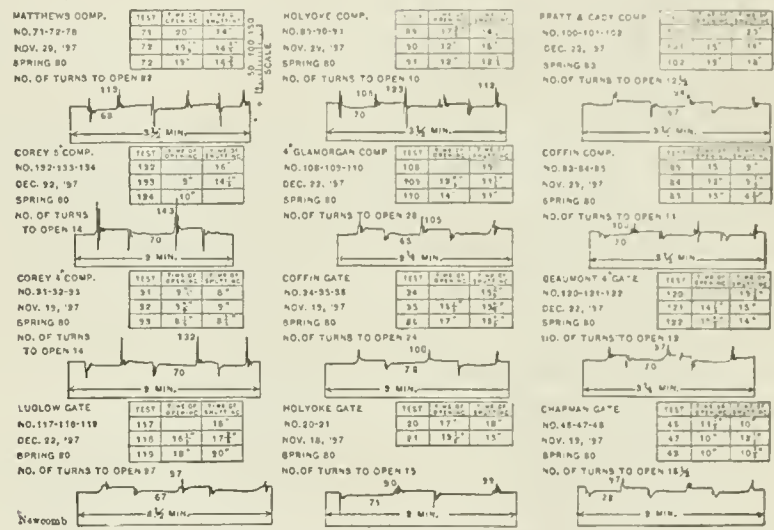


Fig. 1—Water Hammer Cards.

drant draft. It does, however, give a rough means of comparing the different hydrants.

The cards show that the gate hydrants give generally considerably less water-hammer than the compression type.*

It was stated in explanation of the large hammer effects found in one of the special type of compression hydrants that firemen demand a hydrant which will give the full pressure at the earliest possible moment, so that a quick movement was purposely designed. It is firmly believed that in the long run it will be very much better to insure the safety of water mains by avoiding heavy water-hammer effects than to

*The comparatively small hammer shown by the Coffin Compression is probably explained by the special double-beat valve, which is designed to give a more gradual closing than is ordinarily obtained with the compression type of gate.

The small hammer shown by the Pratt & Cady Compression is probably largely due to the fact that, when near the point of closing, the stream begins to go hard, preventing a quick shutdown. The results are, therefore, not fairly comparable with the other hydrants. In the other hydrants the force required to open and close appeared about normal.

boiler, which was being operated, prior to the installation of a special system of draft, which is about to be discussed, at about 125 h. p. We were using No. 1 buckwheat coal, costing the company \$2.30 per gross ton (the price of this coal is now \$2.40 delivered), and were burning it with chimney draft, carefully regulating the damper by hand.

This station, pumps approximately 1,500,000 gals. in twenty-four hours against a head of 342 ft., and after very thorough tests, it was found it was costing on the average \$14.10 per million gallons pumped for coal alone. This, of course, was very easily determined by placing a scale in the boiler room and weighing all the coal used.

The gallons of water pumped every 24 hours, we have, of course, always kept a very careful record of, like all good water works men.

To determine the performance of the

*Abstracted from the Proceedings American Water Works Association.

boiler during every hour of the day, a steam pressure recording gauge was installed, and likewise, a water meter was placed on the feed water line, so as to be able to compute the evaporative efficiency.

After getting everything in shape, we were able to gather the records together daily for analysis, and followed the coal consumption, etc., closely day after day for quite a long time. From the results thus obtained we calculated that the coal was costing us on the average, \$14.10 per million gallons pumped, as heretofore stated.

In the determination to lower this coal cost, we were first lead to the study of various systems of draft production. We reasoned that if we could secure a system of draft that would burn a cheaper grade of fuel than No. 1 Buck, and would get the heat units out of this cheaper coal, we could save the company a great deal of money on their coal bills.

We had attempted to burn Rice or No. 2 Buckwheat once before with a "Steam Jet Blower," but found that the increased consumption of this cheaper coal more than offset the difference in price. Besides the "Steam Jet" is an inordinately wasteful contrivance for the production of draft, using as is well known, anywhere from 10% to 25% of the steam generated by the boiler to operate it. The "Jet" was therefore abandoned and we went back to the use of No. 1 Buckwheat.

After considerable time spent in investigation we finally came across a "Draft System," which we concluded came as near to producing the ideal conditions for perfect combustion in the furnace chamber as possible in ordinary practice. This system is called "The McLean Balanced Draft System of Furnace Regulation."

We decided to give it a trial and immediately asked for a proposal from the company which is marketing the system. In a short time we had it installed.

The company had guaranteed under contract to save us 20% in our fuel bill, operating with No. 3 Buckwheat, or (Barley coal) at \$1.20 per gross ton delivered, as against operating with No. 1 Buckwheat coal, at \$2.30 per gross ton delivered and natural draft.

The resultant fuel saving has proven to be so large, the writer decided it was his duty to bring the subject to the attention of his brother members of the association at this meeting.

The writer will briefly outline the comparative results obtained, and then give you, gentlemen, a short description of the system.

Careful evaporation tests were made, first under the old method, that is No. 1 Buckwheat coal and Natural Draft and then with No. 3 Buck, or Barley coal with "Balanced Draft."

The net fuel saving at this station to the company under the new system was 40%, the boiler developing at the same time a higher rating than with the old

method. The coal cost per million gallons pumped was reduced from \$14.10 to \$8.44 and the coal log has shown this saving regularly ever since.

Besides the steam pressure is kept wonderfully regular, and we have no question but that we will notice a marked reduction in the cost of maintenance of both boiler and setting.

The equipment consists of the following parts: First, a small turbine blower set directly against the ash pit wall, through which an opening is made to admit the air to the ash pit. The turbine exhausts into the ash pit. Its speed is automatically regulated by a special type of regulating valve.

A diaphragm damper controller is used, connected in such a manner to the blower, that the same variation of steam pressure that changes the speed of the blower, simultaneously changes the position of the damper.

The blower and damper are so adjusted, relatively one to the other, that there is at all times practically atmospheric pressure in the furnace chamber.

For each and every change in the speed of the blower, the damper assumes a different position within the limits of its travel. The air supply to the furnace and the exhaust of the gasses from the furnace thus have a constant relation one to the other and the draft is at all times "balanced" against the atmosphere; hence the name "Balanced Draft."

The average steam consumption of the turbine is approximately 2% of the steam generated.

It is not the writer's purpose to discuss at length the theory of this subject, but the fact that at one stroke the system saved his company in one of its single boiler installations, about \$1,300 per year impressed him so strongly that he feels justified in urging upon the members of this association an investigation into the fuel saving it would undoubtedly accomplish in any water plant.

Of course, in larger boiler plants, the company does not use the turbine blower.

They have a special type of fan blower for installations above one or two boilers which requires on the average only 1½% of the steam generated for its actuation.

The claims made for the Balanced Draft system, and the writer has no doubt that each and every one of them can be substantiated, are as follows:

First: That it will make a full saving of, at least 10% over any other system of draft on the market, using the same coal. If a cheaper grade of coal is obtainable, the saving will be materially increased.

Second: That the most inferior coal can be successfully and economically burned getting out of it the maximum number of heat units possible.

Third: That the capacity of a boiler is 20% to 25% greater by virtue of the "balancing" of the draft; that is to say that a

100 h. p. boiler, builders rating, without "Balanced Draft" becomes 120 to 125 h. p. with "Balanced Draft."

Fourth: That the cost of maintenance of a boiler and setting will be greatly reduced, because of the eliminating of the strains of expansion and contraction due to the variation in the furnace temperature caused by the infiltration of cold air through the bricks and through leaks in the setting; likewise by the influx of cold air through the fire doors when open.

Fifth: The suction of the chimney with this system is entirely eliminated. I have flung my fire doors wide open time and time again to determine the effect upon the steam pressure. It had no effect whatever, the steam pressure is apparently maintained just as easily. A piece of paper thrown through the fire door onto the fire will lay and burn wherever it strikes the fire, which indicates a perfect "balance" or in other words that the chimney suction is practically nil.

Sixth: That an even steam pressure will be maintained.

Seventh: That the horsepower capacity of any stack is practically doubled. The pamphlets explain clearly the reason for this.

Eighth: That great overload capacities can be developed.

Ninth: That the time between cleaning of fires can be safely doubled.

According to a report of an admiralty committee of the British navy on deep water diving, diving operations can be carried out with safety in depths up to 210 ft., provided proper precautions are adopted and suitable appliances used. The committee report that the respiratory distress which, under the conditions of diving hitherto obtaining, usually prevents divers from working at more than very moderate depths, such as 15 to 20 fathoms, is due to the pressure of carbon dioxide in the air in the helmet, and can be entirely obviated by increasing the supply of air in direct proportion to the increase in the absolute pressure. To enable a sufficient supply of air to be delivered to the divers two or more pumps should be coupled together when operations are being carried out in depths exceeding 18 fathoms. The serious dangers arising from the liberation of bubbles of nitrogen in the blood and tissues on the ascent of a diver from deep water can best be met by (1) Limiting the time spent in deep water; and (2) ascending most of the distance rapidly, and afterwards making the last part of the ascent in stages, with stoppages interposed.

An ordinance is now before the City Council of Chicago, Ill., providing for the abolishment of many dangerous grade crossings in the southern part of the city. The work will cost between \$5,000,000 and \$6,000,000 and will require the construction of 46 subways.

Railway Section

Note: This section is devoted to methods and costs of constructing railways. It will cover road-bed and track construction, contractor's plant and organization, surveying methods and permanent way structures.

The Cost of Driving an Earth Tunnel for a Railroad.

During the past decade a large number of descriptions have been written of driving tunnels through rock, but only a few tunnels excavated through soft materials have been described in engineering literature, and then only those in which special methods were used, or unusual difficulties encountered. The tunnel described in this article could not be classed as unusual in any respect, nor were any novel methods used on the work, but inasmuch as we are able to give the itemized cost of the tunnel, it may prove of interest.

The tunnel was on the line of one of the large western roads, on the outskirts of a town, crossing under some of the

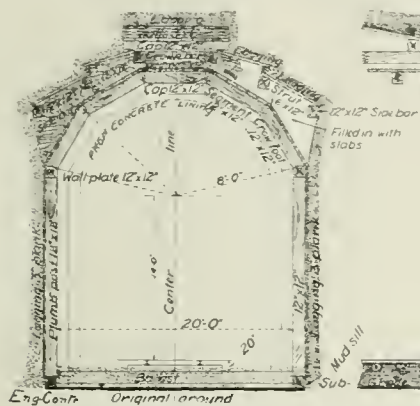


Fig. 1.

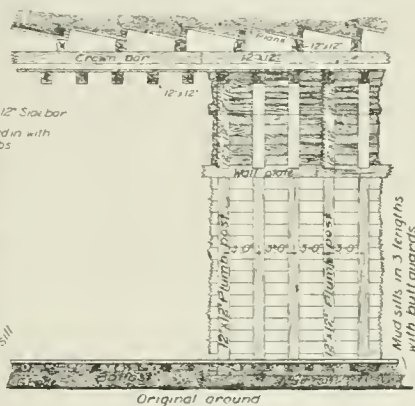


Fig. 2.

streets, but without many houses in that neighborhood. The length of this single track tunnel was 2,360 ft. It was lined with timber as shown in Figs. 1 and 2. The cross section was designed to have ultimately a lining of concrete. There were about 15 cu. yds. of excavation to the running foot figured for the cross section as designed, which meant a total excavation of 35,385 cu. yds., not including any slips or falls.

The material excavated was mostly a glacial deposit or till, there being at one end some cemented gravel that had to be blasted while the other end was mostly sand. Temporary timbers had to be used and some trouble was experienced with the earth slipping, as the method of putting in the timber roof shows.

The work was done by company's forces and the following wages were paid, the working day being 10 hrs.

Resident Engineer	\$250.00 per mo.
Asst. Engineer	125.00 per mo.
Transitman	85.00 per mo.
Draftsman	75.00 per mo.
Rodman	50.00 per mo.

Chainman	40.00 per mo.
Axeman	2.25 per day
Extra chainman	2.25 per day
Superintendent	225.00 per mo.
Accountant	75.00 per mo.
Purchasing agent	70.00 per mo.
Material clerk	70.00 per mo.
Clerk	40.00 per mo.
Cook	45.00 per mo.
Heading foremen	5.00 per day
Bench foremen	4.00 per day
Track foremen	2.50 per day
Foremen	2.50 per day
Miners	3.00 per day
Muckers	2.00 per day
Nippers	2.00 per day
Team and driver	5.00 per day
Horse and driver	3.00 per day

Rail drillers	2.50 per day
Trackmen	2.00 per day
Dumpmen	2.00 per day
Carpenter foreman	3.50 per day
Carpenters	2.50 per day
Blacksmith	3.00 per day
Helper	2.00 per day
Timber inspector	2.50 per day
Timekeeper	2.25 per day
Motormen	2.75 per day

The following men were used at times and paid the following wages:

Electrician	\$100.00 per mo.
Lineman	\$2.50 to 2.75 per day
Carshop foreman	3.00 per day
Carshop carpenter	2.50 per day
Machinists	\$2.50 to 3.50 per day
Masons	4.00 per day

Engineering and Superintendence.—Under this head is given the cost of superintendence and the engineering work. The superintendence was a cost that would have come under the contractor's item of general expense, if the work had been done by contract. The two items of engineering and superintendence were kept together, but the superintendence was more cost-

ly than the engineering, as the resident engineer gave only part of his time to the tunnel work, and even the assistant engineer's salary was not charged in full against the tunnel. The items going to make up this charge were:

Payroll	\$1,582.67
Supplies and incidentals	174.81
Board	663.99
Telephone for office	21.30
Light for office	61.16

Engineering and Superintendence \$5,544.93

This gives a cost of 16 cts. per cu. yd. of excavation and a cost of \$2.35 per lineal ft. of completed tunnel.

Camp and Offices.—A camp was built near the tunnel site for the men to live in, and an office was also established for the superintendent and the engineers. A temporary depot was built, and a freight house to store supplies. Electric lights were used in some of these buildings, and water was also placed in some, being procured from the town.

The total cost of camp was \$1,177.93, and, as some of the buildings were sold and the depot was given to the operating department of the road, a credit of \$492 was made to this account, making the net cost of the camp \$2,685.93. This means a cost per cu. yd. of excavation of 8 cts., and a cost per lin. ft. of tunnel of \$1.14. When work is done by contract the item of camp comes under general expense, but, as a contractor usually charges his men a small rental for houses or bunks, there are generally enough credits made to the camp account to about balance it.

Plant.—In spite of the length of this tunnel, being such as to class it as a long tunnel, a compressor plant was not used, but an electric motor was installed and used in operating a motor car to haul material from the tunnel. The motor had been used on some other job and had to be repaired. The total charge for motor, supplies, repairs, operation and power was \$3,132.29. When the tunnel was finished the motor was sent to another tunnel that was being driven and a credit was made for the motor of \$1,606.36, and \$360 for power furnished for other purposes, leaving a net charge of \$1,165.93. The cost per cu. yd. of excavation was 3 cts., while the cost per lin. ft. of tunnel was 49 cts. In contract work this item would be classed under the head of plant.

Tools.—The tools used on the job were small ones for the excavation and timber work, with the exception of the electric locomotives and the cars for hauling earth and timber. The cost of the tools and supplies was \$6,520.01. The cost of repairing and maintaining these was:

Labor	\$2,684.95
Coal	135.38
Lumber	195.76
Iron	417.64

Total

\$3,433.73

This makes a total expenditure for tools of \$9,953.77. At the end of the job, a credit was made of \$3,929.16 for tools and supplies sent to another job, leaving a net charge for tools of \$6,024.61. This charge properly belongs under the item of plant, yet, inasmuch as the depreciation on small tools is much greater than on machinery, it is well to keep a separate account of tool. The cost per cu. yd. for tools was 17 cts., and the cost per lin. ft. of tunnel was \$2.55.

Explosives.—A car load of Forcite dynamite was bought for the job, but only a small part of it was used. The strength was 40 per cent, and it cost 12¼ cts. per lb. Two 30-hole exploding batteries were bought, and electrical exploders to use with the batteries. The total cost of explosives was:

Dynamite & exploders.....	\$2,638.48
2 batteries	80.00
Wire	40.00

Total\$2,758.48

At the end of the job, the batteries and unused explosives were sent to another piece of work. A credit of \$60 was made for the two batteries, and \$2,030.29 was credited for the explosives. Consequently there remained a net charge of \$668.19 for blasting. This makes a charge of 2 cts. per cu. yd. and 28 cts. per lin. ft. of tunnel.

Tunnel Excavation.—The excavation was done in the usual manner. The heading was excavated and timbered, then widened out and the roof supported in the manner shown in the illustrations, with the addition of temporary props. Then the bench was excavated and the permanent timbering finished. The excavated material was wheeled out of the heading in wheelbarrows, and horses were used in pulling the cars from the bench excavation to the dump, but as the haul became long, the electric locomotives previously referred to were used. Candles were used to give light in the headings, the expense for this being \$116.71. Electric wire was strung for the motors and also for lighting purposes. The costs for the hauling has been included in that for plant, but this work for the lighting and the power rented, with the lights, wires, etc., cost \$1,191.57, making a total cost of \$1,308.28. This makes a cost of 4 cts. per cu. yd. for lights, and 55 cts. per lin. ft. of tunnel.

Another item of cost was some incidentals on the outside of the tunnel, such as small drains at street crossings, some clearing, a temporary trestle, the blocking up of a warehouse, and other details on which \$1,158.27 was spent for materials and labor. For these incidentals the cost per cu. yd. was 3 cts., and the cost per lin. ft. of tunnel was 49 cts.

The expenses for labor and teams was \$75,762.10, making a cost per cu. yd. of \$214 and per lin. ft. of tunnel of \$32.12.

Timber Lining. The total amount of timber used was 2,434,200 ft. B. M., cost-

ing \$20,223.18. This is exclusive of wedges, cordwood and iron. Cordwood was used for packing, the plans calling for 533 cords, but only 151 cords were bought, the price per cord being \$1.50. The deficiency was made up by using old pieces of temporary timbers and scraps. The cost of the cordwood was \$658.16. Wedges were made from 2x12 boards, and cost to make from 1¼ to 2 cts. a piece. These were made by contract, about 15,000 being used, costing \$2,586.95. The iron and nails used cost \$669.79.

The amount of permanent timber called for by the plans was 1,687,200 ft. B. M. The average price paid for this was \$8.40 per M. In addition to this 747,000 ft. B. M. were used as temporary timbers and for other purposes. This cost an average price of \$8.10 per M. The cost of labor for framing and placing timber, exclusive of the time of the men from the mucking gangs that may have been used temporarily, was \$8,615.40. This gives a cost for framing and placing per M. ft. of timber as called for by the plans of \$5.10, while the cost per M. for the total amount of timber used was \$3.54. Separate record was not kept of placing the cordwood. The total cost of the lining was:

Lumber	\$20,223.18
Cord wood	658.16
Wedges	2,586.95
Iron	669.79
Labor	8,615.40

Total\$32,753.48

The cost of each of these items per cu. yd. of excavation was:

Lumber at \$3.30	\$0.57
Cordwood	0.02
Wedges	0.07
Iron	0.02
Labor	0.24

Total\$0.92

The cost per lin. ft. of tunnel was:

Lumber at \$8.30	\$8.53
Cordwood	0.28
Wedges	1.09
Iron	0.28
Labor	3.65

Total\$13.83

Personal Injury.—No one was killed in building this tunnel; however, a number of men were hurt, but none seriously. Various expenses were incurred on account of those injured, there having been paid out \$2,170.45, making a cost per cu. yd. of 6 cts., and per lin. ft. of tunnel of 92 cts.

Summary of Cost.—The total cost of the entire work was:

Engineering and Superintendence	\$ 5,544.03
Camp	2,685.93
Personal Injury	2,170.45
Plant	1,165.93
Tools	6,024.61
Expenses	668.19

Tunnel Excavation:

Light	1,308.28
Incidentals	1,158.27
Labor	75,762.10
Timber Lining:	
Lumber	20,223.18
Cord Wood	658.16
Wedges	2,586.95
Iron	669.79
Labor	8,615.40

Total\$129,241.27

The cost per cu. yd. for each of these items was:

Engineering and Superintendence.....	\$0.16
Camp	.08
Personal Injury	.06
Plant	.03
Tools	.17
Explosives	.02

Tunnel Excavation:

Light	.04
Incidentals	.03
Labor	2.14
Timber Lining:	
Lumber	.57
Cord Wood	.02
Wedges	.07
Iron	.02
Labor	.24

Total\$3.65

The cost per lin. ft. of tunnel for each item was:

Engineering and Superintendence...	\$2.35
Camp	1.14
Personal Injury	.92
Plant	.49
Tools	2.55
Explosives	.28

Tunnel Excavation:

Light	.55
Incidentals	.49
Labor	32.12
Timber Lining:	
Lumber	8.53
Cord Wood	.28
Wedges	1.09
Iron	.28
Labor	3.65

Total\$54.82

The total payroll on the job amounted to about \$90,000 and it will be noticed that the amount paid out for personal injuries was \$2,170.45. If liability insurance had been taken out for this job the rate would have been less than 2 per cent, hence money would have been saved. It is always well on construction work to carry this kind of insurance.

No record was kept of the slips and slides that occurred in the tunnel, but some must have occurred as glacial drift is apt to be treacherous material to tunnel through, and this must not have been an exception to the rule, as the large amount of temporary timber used bears witness.

Considering the high wages paid, and the fact that the work was done by day labor, the cost is not excessive, but no doubt timber was wasted, yet the prompt use of tem-

porary timbers in some places may have saved money when heavy slips were threatened.

The engineering and superintendence together were less than 5 per cent of the total cost. This would mean that the engineering expense did not exceed 2 per cent, and the cost of locating the work is included in this. The item of general expense, as a contractor would have classified it, including superintendence, camp, and personal injury, was about 6 per cent. This could have been cut down a little by taking liability insurance, and charging rent for the camp. The plant and tool charge was a little more than 5 per cent. The tunnel lining was 25 per cent of the total cost.

The excavation of the heading was commenced in March. Work was started at both ends of the tunnel. During April no work was done inside the tunnel, but in May active operations were commenced and night and day forces were put to work. The headings were finished in August, and the benches cleaned up by the middle of September. Each heading foreman worked from 9 to 10 men, while the bench foremen worked from 15 to 20 men in their gangs. At one end of the tunnel a bench sub-foreman with extra men were used for several months. When work first commenced, the track gangs had from 10 to 15 men in them, there being a track gang for each end of the tunnel; but, as soon as the work was well under way, these gangs were cut down to 6 men each, and at the end only 4 men were kept in a gang. The timber gangs, consisted of a foreman from 7 to 10 carpenters and a timber inspector. There was a night and day gang of carpenters from May to September.

A railroad in Honduras which has just been opened to traffic as far as Ceiba, 35 miles, was built with creosoted pine ties from the United States.

The following table, compiled from a recent bulletin of the College of Engineering of the University of Illinois shows, for each class graduated from that department since 1893, the percentage of the total number of men in the class who are at present engaged in engineering work:

Class.	No. Graduated.	Per Cent Now in Engineering Work.
1893.....	28	79
1895.....	47	96
1896.....	39	69
1897.....	52	85
1898.....	45	96
1899.....	47	92
1900.....	39	85
1901.....	42	69
1902.....	56	95
1903.....	53	98
1904.....	99	94
1905.....	96	100
1906.....	132	100
1907.....	140	100

Bridges, Buildings and Foundations

Note: This section is devoted to methods and costs of constructing steel and masonry bridges and buildings and of foundation work of all kinds. It will give special attention to erection plant and tools, falseworks and centers and cost data of all kinds.

Method of Erecting Transmission Line Towers in Assembled Condition by Means of Gin Poles with Some Data on Cost.*

The towers were built to carry two three-phase 20,000-volt circuits of No. 4 hard-drawn copper wire, the insulators being triple petticoated and tested to 60,000 volts. A ground wire is placed in the center on the upright pipe for lightning protection, and two telephone wires are carried on insulators mounted within the steel pole structure. They are of structural steel heavily galvanized, and were shipped in bundles, most of which could be handled by four men. There were four similar pieces for one tower, the large cross arm and the pipe for ground wire, being very heavy, were shipped separately. The towers were assembled in the field with bolts and nuts heavily galvanized over the threads. The net weight of each standard tower is 2,200 lbs.

Several methods of erection were considered, the most popular suggestion being the movable A-frame. This method, as well as others, could not be used for several reasons. The center of gravity of the towers is very high, and the steep slopes upon which they had to be erected would have made it necessary for the A-frame to work at right angles to the line, in which case the tower would have had to be turned after erecting owing to the necessity of assembling it with the cross arm lying flat upon the ground. Some of the hills were so steep that the towers had to be cut away to fit before erection, and separate concrete anchorages were used for laterals and horizontals braces. There were few level spots. The weight of an A-frame would have been too great in one piece, as it had to be carried by hand from tower to tower, because of the broken character of the country. Moreover, the bottom legs of the tower were too flexible for the weight thrown on them sideways during erection in a manner not contemplated in the design. While the lateral braces were large enough for the tension which will come on them after erection by reason of the pull due to wind pressure, they could not carry the compression which would have come on them in resisting the stresses developed by the eccentric loading at the end of the leg during erection.

As a result of these conditions peculiar to the tower and the country, the follow-

ing method was employed for application by an American general foreman, all of the rest of the labor, with one exception, being Porto Rican.

One gang in charge of a Porto Rican engineer dug the holes, put in the concrete footings, and cut off or lengthened the lower legs to correspond to the slope of the hillside. Another gang assembled the towers with the exception of the lower leg pieces, while another gang erected the small gin-pole. Then came the main erecting gang carrying large gin-poles, blocks, tackle, dead-men, tools, etc. The small gin-pole being in place, the last gang quickly erected the first large gin-pole, which in turn was used to erect the second.

The most difficult problem at each tower was the anchoring of the many guy lines needed. For this purpose trees were occasionally used, but in most cases steel dead-men had to be driven in the ground; in some cases the ground was so soft that two dead-men had to be used. The erecting of the main poles was in charge of a mate from a Porto Rican sailing vessel, as sub-foreman, his principal assistants being six sailors whose carefulness and good judgment were such that only twice did the gin-pole break away.

At each angle point, the tower was set to bisect the angle in the transmission line, a supporting guy being held by concrete anchorage. Four or five towers were erected per day. After the men had gained a little experience the cost of erection, including all labor and material, sub-delivery of towers and concrete, cement at \$3.50 per barrel at the tower, assembling, erecting and concrete footings and casing was brought down to from \$25 to \$27 per tower. Owing to special work, and some towers in exceptionally bad locations, which required more care and more concrete, and owing to delays caused by right of way fights, the average cost was considerably higher. Each common laborer was paid 75 cts. per day, the sub-foreman receiving \$2 or \$3.

At the beginning of the year 1907 the rolling stock of the state railways of Chile consisted of 4,000 cars, with a total tonnage of 50,000 tons, and during the year 1,400 cars were added, with a tonnage of 40,000 tons, making the total tonnage in use on the state railways at the close of the year 90,000 tons. During the year 1907 this rolling stock handled 3,400,000 tons of freight, against 2,800,000 tons for 1906.

*Condensed from an article by W. R. Strickland in "Electrical World" for June 13, 1908.

The Method of Removing the Large Train Shed at Grand Central Station New York.*

GEORGE A. HARWOOD, M. AM. SOC. C. E.

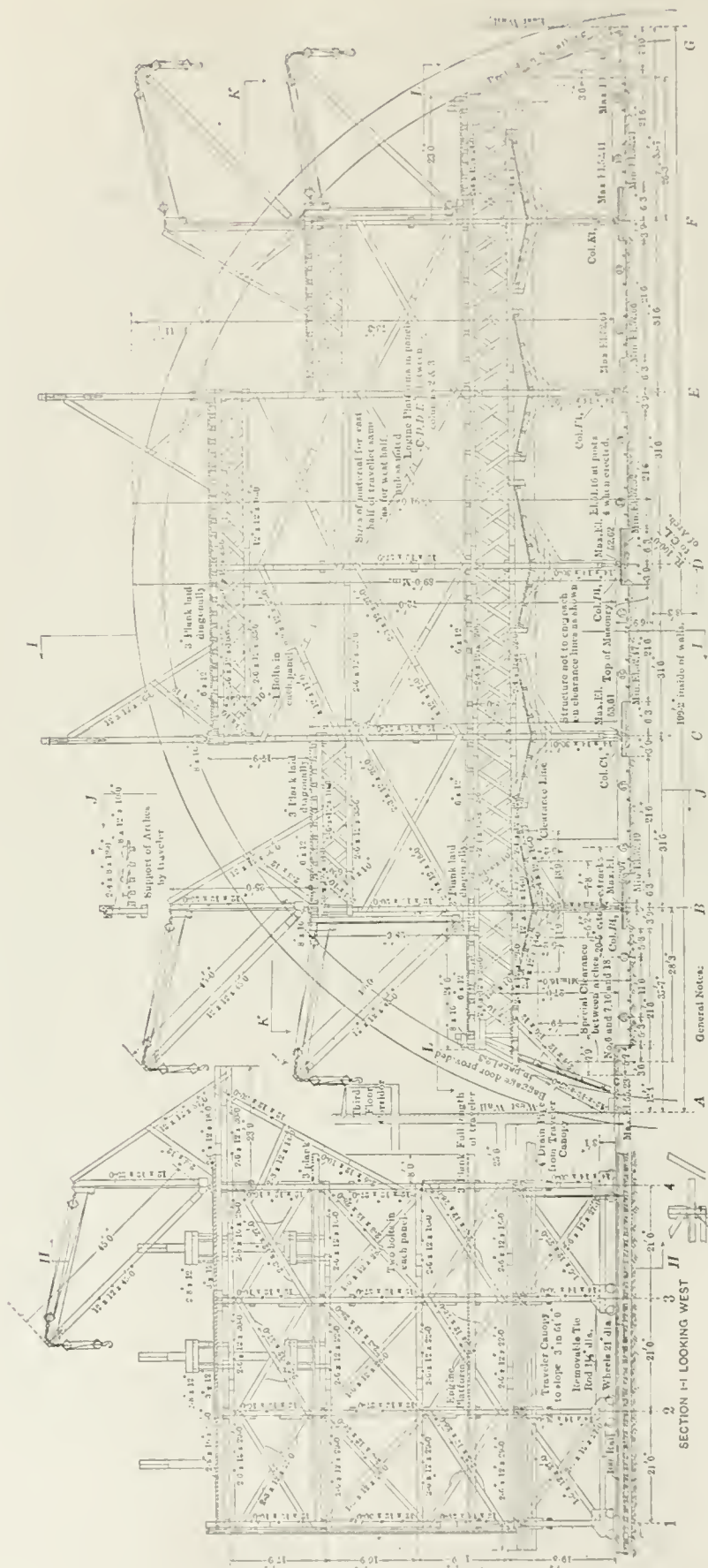
Some features of the improvement which have been taken up since the paper was prepared, may be of interest. The most important of these is the removal of the train-shed of the Grand Central Station.

It was originally contemplated that traffic would be transferred to the new east side station before it became necessary to remove the old train-shed. This was prevented by the increase in traffic and the progress of the excavation. Last fall, therefore, it was decided to remove the shed while the through passenger trains of the New York Central and the through and local trains of the New Haven continued to use the old station.

It is proposed to remove all of the shed north of the passenger waiting-room. The length of this portion is about 600 ft., and consists of wrought-iron arches, the material for which was imported from England and erected in 1870. The arches are built in the form of a truss, the section being about 4 ft. from back to back of chord tees. They have a span of 200 ft. 1 in., from center to center of pins, with a clear distance of 85 ft. from the top of the platform to the under side of the arch. The bottoms of the arches are tied together under the tracks with 3-in. rods. The distance from center to center of arches, longitudinally, is 20 ft. 3½ in. There are about 1,350 tons of wrought iron, 350 tons of cast iron, 90,000 sq. ft. of corrugated-iron roofing, 60,000 sq. ft. of glass, and 530,000 brick to be taken down, loaded into cars and removed from the terminal without interference with the regular business.

To accomplish this, and reduce to a minimum the possibility of accident by falling material, it was decided to erect a traveler, the outlines of which would conform to the general contour of the train-shed, spanning all platforms, with heavy floors extending the entire width of the shed. The supports for the traveler, details of which are indicated by the accompanying illustration, rest on the five intermediate platforms, and are carried on heavy cast wheels which roll on standard 100-lb. rails. The load on each platform, including the weight of two of the train-shed trusses, is 200 tons, this being distributed over the entire width of the platform by ties supporting the rail, and covered with temporary planking so as not to interfere with the use of the platform for regular business. The traveler contains 370,000 ft. B. M., of lumber, 65 tons of bolts and washers, and 33 tons of plates and castings. It has a length of 65 ft., which will permit of blocking up

*Abstracted from a discussion on a paper on "The Electrification of N. Y. C. & H. R. R.," printed in Vol. XXXIV, p. 496, of the Transactions of the American Society of Civil Engineers.



Cross-section of Traveler Used in Removing Train Shed at Grand Central Station, New York City.

Note: Track to grade down to south 1 in 100. Length of material given here is ordered length only. Flooring short-leaf yellow pine. Sheathing and louver, Spruce. For all other work use inspected long leaf yellow pine. 1" dia. bolts used throughout unless noted otherwise. Platforms to be pitched to drain to south face of traveler. Channels to be pitched to drain north. Traveler to have two rails of main track in shed has been dismantled in case it is decided that traveler will remain for protection of concourse. Max. dead load on Col. 60,000 lb. Cols. 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. Max. live load on Col. 88,000 lb. Cols. 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. Max. Total load on Col. 150,000 lb. Cols. 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. Wind Load 30 lb. per sq. ft.

two of the shed trusses on it at the same time. It is equipped with six stiff-leg derricks which are operated by two engines. Flaps are hung on the sides, from the first platform level, to protect passengers on the outside station platforms. The south face is boarded over, forming a false end for the train-shed as the traveler moves south. The material was all framed at the company's yard at Harmon. Portions ready for erection were then brought into the station and set, up to the elevation of the first floor, at night. After this had been placed, the remainder of the traveler was erected during the day, the members being brought in and lifted to the first-floor level at night.

As fast as the traveler is moved south it is followed up with temporary wooden canopies, thus subjecting the platforms to a minimum amount of exposure. As soon as the traveler has been moved to a new position and blocked up, two train-shed trusses are blocked on top of it, and the corrugated-iron roofing, glass, skylights, and purlins are removed. The northerly truss is then cut into eight sections by using hacksaws and knocking off the rivet heads at the joints. The derricks then place these sections on the traveler platforms, all this work being done during the day. The night gang loads the material from the platforms in cars placed on the passenger tracks under the traveler.

The traveler is moved by jacks, two 15-ton jacks being placed on each platform, and each being operated by two men at signal so as to maintain a uniform movement. The work is done in units of 40 ft., and it requires 5 hours to move the traveler this distance. Now that the north portal and the first few northerly bays are removed, it is expected that the average progress will be about one truss for each 4 days.

The taking down of the north portal was the most delicate part of the operation, on account of the necessity for cutting away all connections between the portal and the train-shed before the work of demolishing could begin. The north end of the traveler was constructed with beams projecting 5 ft. beyond the face. These were pushed through the window openings, or through openings cut in the metal sheathing, and the entire portal was lashed to the traveler. Wooden troughs were constructed at the various platform levels so as to prevent loose metal from falling on the tracks below.

Leon Delagrangé, the French aeroplane operator, in a flight at Milan June 22 remained in the air 16½ minutes and went a little more than eleven miles.

The survey for the 2,000-mile Kalabagh-Makarwad Ry. in India has been started. The first-named terminus has salt mines and the other a rich coal mine near by, worked by Rai-Sahah Anup Singh.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Tests of the Spreading Power of Paints.

Mr. Wm. T. Magruder, professor of mechanical engineering at the Ohio State University, conducted a series of tests at the shops of the Pennsylvania R. R. at Columbus, Ohio, to determine the spreading power of certain paints under various conditions.

The painting was done on flat plates of ¼ in. steel, 5 ft. wide and 9 to 10 ft. long, having from 45 to 48 sq. ft. of area. Old and rusty sheets were cleaned by wire brushes and some were sandblasted. New sheets were coated with mill oxide. Freshly opened cans of ready mixed paint were used and the red lead was freshly mixed

A Large Dredging Contract: The Inland Waterway from Pamlico Sound to Beaufort Inlet, N. C.

Bids are now being asked by Capt. Earl I. Brown, Corps of Engineers, U. S. Army, Wilmington, N. C., for constructing an inland waterway from Pamlico Sound to Beaufort Inlet, N. C. The work according to information prepared by Mr. G. C. Scherer,* will necessitate dredging 3,500,000 cu. yds. of material. The river and creek portions of the waterway will offer but the usual dredging problem, the material being thought to consist of soft mud, sand, clay, shell and silt; it is not believed that rock, large boulders or com-

DETAIL SUMMARY OF THE TESTS OF THE SPREADING POWER OF PAINTS

Make of Paint.	Specific Gravity of Paint	Weight, lbs. per gallon	Temperature, Fahr.	Mixed Paint Used in				Cost of Materials.			
				Area covered in sq. ft.	Humidity, per cent	Pounds	Gallons	Thin used in mbls.	Per gallon	Per 100 sq. ft.	
First Coats on Sandblasted Plates.											
Carbonizing coating.....	1.12	9.35	85.5	45%	46.18	0.35	0.037	1226.9	11.5	\$1.50	12.23 cts.
Red lead, 30 lbs. to 1 gal. oil.....	3.25	27.01	85.8	45%	46.18	1.03	0.038	1203.2	17.5	2.11	17.54 cts.
Red lead, 35 lbs. to 1 gal. oil.....	3.53	29.41	78.7	53%	46.80	1.43	0.049	1035.0	29.4	2.32	22.41 cts.
Detroit Superior Graphite.....	1.31	10.90	80.2	50%	46.79	0.56	0.052	918.2	12.3	1.25	13.61 cts.
Second Coats on Sandblasted Plates.											
Carbonizing coating.....	1.19	9.90	78.0	43%	46.17	0.37	0.038	1222.1	8.5	\$1.10	12.27 cts.
Red lead, 30 lbs. to 1 gal. oil.....	3.23	26.89	80.5	42%	48.12	0.96	0.036	1359.6	22.0	2.11	15.52 cts.
Red lead, 35 lbs. to 1 gal. oil.....	3.56	29.63	78.3	44%	47.19	1.04	0.035	1345.4	16.5	2.32	17.24 cts.
Detroit Superior Graphite.....	1.30	10.84	75.3	44%	47.26	0.55	0.050	1001.2	10.2	1.25	12.49 cts.
First Coats on Rusted Plates. Not Cleaned, Only Wire-Brushed.											
Carbonizing coating.....	1.07	8.87	95.0	47%	43.08	0.43	0.048	898.0	11.5	\$1.50	16.70 cts.
Red lead, 30 lbs. to 1 gal. oil.....	3.35	27.88	82.0	47%	33.42	2.16	0.077	432.3	17.0	2.11	48.80 cts.
First Coats on Mill-Oxide Plates.											
Carbonizing coating.....	1.19	9.90	77.0	45%	46.15	0.31	0.031	1473.4	8.8	\$1.50	10.18 cts.
Red lead, 30 lbs. to 1 gal. oil.....	3.27	27.18	81.0	68%	46.93	0.99	0.036	1293.2	12.0	2.11	16.31 cts.
Red lead, 35 lbs. to 1 gal. oil.....	3.60	29.95	78.0	46%	46.15	1.46	0.049	949.8	12.2	2.32	21.42 cts.
Detroit Superior Graphite.....	1.28	10.64	80.0	73%	43.19	0.41	0.039	1108.4	9.8	1.25	11.28 cts.
Raw linseed oil.....	0.93	7.77	77.0	45%	46.11	0.12	0.015	3020.1	7.7	0.40	1.32 cts.
First Coats on Sandblasted Plates. Well Brushed Out. Thin Coats.											
Carbonizing coating.....	1.19	9.92	80.0	72%	46.20	0.19	0.019	2432.4	19.8	\$1.50	6.16 cts.
Raw linseed oil.....	0.93	7.77	80.0	72%	46.20	0.12	0.015	3043.2	13.0	0.40	1.31 cts.

with raw linseed oil and kept constantly stirred during the painting. A new 6/0 Extra B Wolfe brush was used with each paint. The cans of paint with their brush and stirrer were weighed and check weighed before and after applying the paint; and from the specific gravities the amounts used were calculated in gallons. All weighings and calculations were made and checked by two persons. The specific gravity of the red lead pigment was 8.86. The painter was instructed to brush the paints out in the usual way to a uniform coat, as if he were painting a tank or car. He did not know in the interest of which paint the tests were being made.

The accompanying table, which is self explanatory, gives the results obtained from the tests.

The Carbonizing Coating is a paint that is manufactured by the Goheen Manufacturing Co., of Canton, Ohio.

fact gravel will be encountered. The greater portion of the canal connecting Adams and Core Creeks lies in heavily timbered swamp.

The work is provided for in an Act of Congress of 1907 which provided for "Improving and Constructing Inland Waterway from Pamlico Sound to Beaufort Inlet, N. C.," and for which the sum of \$550,000 was appropriated under the continuing-contract system. This appropriation provides for what is known as the third division of the inland waterway from Norfolk, Va., to Beaufort Inlet, N. C.; the third division covers a distance of about 50 miles, from Pamlico Sound to Beaufort Inlet. On this distance a minimum depth of 10 ft. at low water is to be secured by dredging Adams and Core Creeks and constructing a canal of the same depth between the heads of these two creeks.

*U. S. Engineers' Office, Wilmington, N. C.

The length of that part of Division 3 upon which improvement is required is about 14 miles, about five miles being through dry land. The channel has its terminus in Beaufort Harbor. Its course is northerly from Beaufort through Newport River and Core Creek to the head of the latter, thence through the intervening land to Adams Creek, and down Adams Creek to the 10-ft. contour in Neuse River. The dimensions of the channel, as given in the Report of the Board of Army Engineers upon which the Act of Congress making appropriation is based, are as follows:

	Bottom Width	Side Slopes
Excavation through dry land..	90 ft.	1:2½
Narrow parts of rivers.....	125 ft.	1:3
Wide parts of rivers.....	250 ft.	1:3
Open sounds and across bars..	300 ft.	1:5

There is now a navigable depth of 5½ ft. at low water in Adams Creek for approximately six miles from its mouth, and a depth of about 1½ ft. at low water over the bar at the mouth of Core Creek on the Beaufort Inlet side. Core Creek is practically bare at low water.

Bids for the work will be opened July 27.

Two New Developments in Road Machinery.

The accompanying sketches show two new machines for road work which have distinctive features of interest. One is an adjustable road drag and the other is a road grader with a carrying truck whose wheels can be adjusted to any necessary inclined position.

Figure 1 is a sketch of the road drag. It is of steel throughout, with the exception of the running board on top; the blades being detachable and reversible steel plates fastened to steel angle carriers. The sketch shows how the blade carriers are hinged to the frame and swung forward or back by an operating lever to any angle with the vertical. In addition to this adjustability of the blades there is an adjustable hitch by which the angular travel of the frame on the road can be regulated. The possibility of adapt-

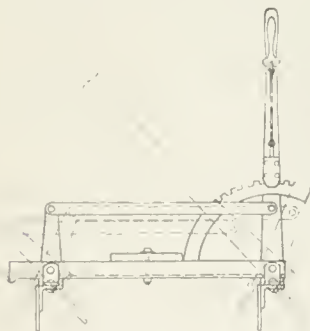


Fig. 1—Adjustable Steel Road Drag.

ing this drag to any kind of soil is clear. Where the roadbed is comparatively level and hard and needs only to be smoothed up the blades may be kept vertical. When the roadbed is rough the blades can be pitched forward to cut away the ridges

and carry the material into the ruts and depressions. In very soft material or when crossing a culvert or bridge the blades are swung backward and ride easily over the surface. It will be noted that the operator can adjust the blades instantly and that the blades are removable as they wear out.

Figures 2 and 3 show the manner in

but in the opposite direction to the pinch which tends to be produced by the earth pressure on the mould board. In Fig. 2 the same machine is shown with the mould board lowered and the earth pressure acting against it as represented by the line F_x . If it be noted that the pressure F_x tends to bind the wheel with reference to the spindles, in the opposite direction

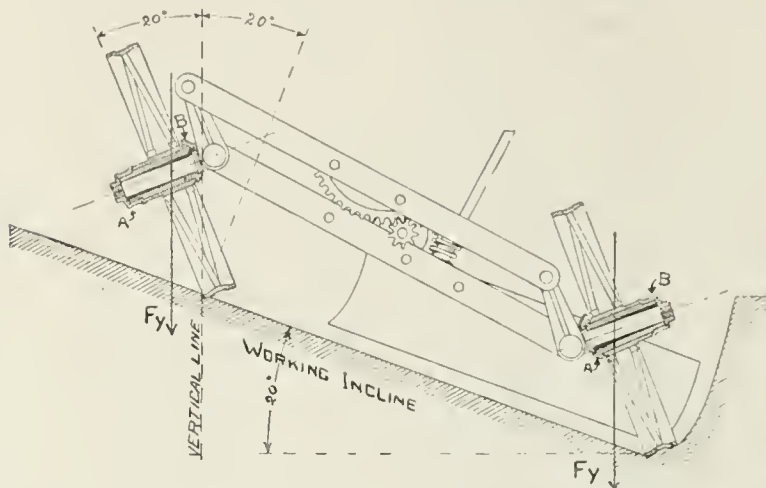


Fig. 2—Diagram of Grader Wheels with Mould Board Raised.

which the wheels are mounted on the carrying truck of the road grader. It will be noted that they can be swung to any angle with a perpendicular to the axle by means of hinged spindles. The purpose of this construction is explained as follows: The wheels of a road machine have two loads to carry, namely the weight of the machine acting vertically and the thrust of the mould board acting parallel

from the pressure F_y , it will be seen that the two pressures counteract each other and the "pinch" on the spindle due to F_y is removed by the counter pressure F_x , so that the wheels bear uniformly on the spindles. In operation the driver swings the wheels by means of the ratchet, spur and worm device indicated until the bearing is even; this is told by the "chuckle" of the wheels on the spindles. In addition

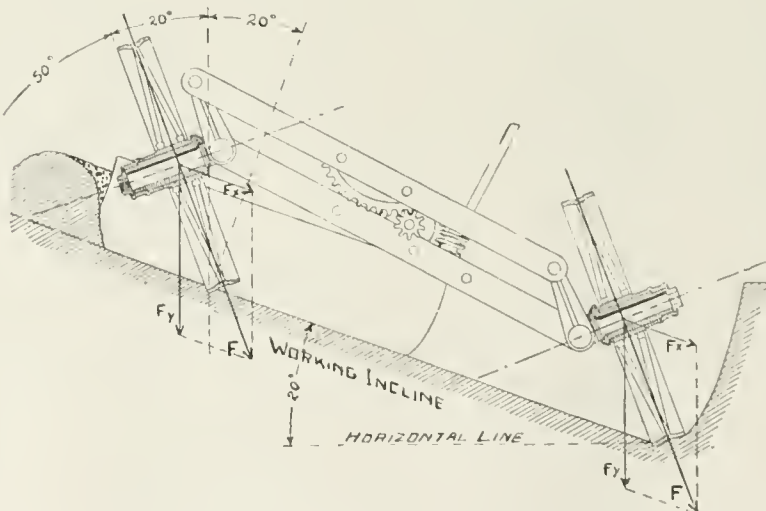


Fig. 3—Diagram of Grader Wheels with Mould Board Lowered.

to the surface of the roadbed. Figure 1 shows the machine set ready for work, but with the mould board up and consequently no side thrust on the machine. The wheels lean up-hill, the pressure due to the weight of the machine and represented by the line F_y causing a side pressure on the upper sides of the wheels and also causing the wheels to "pinch" on the spindles,

to no pinching this arrangement prevents side slipping and does away with side draft. Both front and rear wheels are adjustable as described and either pair can be adjusted independently of the other.

These machines are manufactured by the J. D. Adams Co., Indianapolis, Ind., to which we are indebted for the above information.

Methods and Costs; Some Old, Some New.

Removing Pencil Marks from Tracings.—Blue and black pencil marks can be removed from a tracing by dampening a cloth with benzine and applying it to the tracing. The tracing should be laid on a newspaper, or some paper that is not wanted, before applying the benzine, as it will pass through the tracing and spoil a pencil drawing. Plenty of linen cloth can be obtained by washing out tracing cloth.

Sanitary Inspection of Watersheds.—A new system of making inspections of the Skaneateles watershed near the source of water supply of the city of Syracuse, N. Y., has been put into effect. An index system showing the conditions at places on the watershed and giving a record of the progress of improvements is now kept in the office of the Department of Works. The inspector in his trips around the lake carries in a leather case cards measuring about 8 by 10 ins. One of the cards will be used to show conditions at each piece of property. Upon subsequent visits, if it is found that the inspector's instructions in regard to the removal of temporary nuisances have not been carried out, report will be made to the State Board of Health, making it necessary for the land owners to deal thereafter with state authorities.

Converting Catch Basins Into Inlets.—During the past year the city of Easton, Pa., John McNeal, city engineer, abandoned the practice which required the construction of catch basins on all streets, and has converted the catch basins into inlets, on line of brick-paved streets where the size of sewers was 3 ft. in diameter or larger. This change was made by filling the space below the outlet pipe of the basin, with ashes up to within 6 ins. of the outlet, covering this last 6 ins. with concrete and sloping the surface toward the outlet pipe. A total of 88 catch basins were changed in this way at a cost of about \$2 per basin. The results obtained have been most satisfactory, as the inlets now clean themselves during each storm without causing any deposit in the main sewer. And the city is relieved from the expense of cleaning, which amounted in former years to about 40 cts. per basin per month.

Stretching Tracing Cloth on a Drawing Board.—A good way of stretching tracing cloth on a drawing board is by means of small $\frac{1}{2}$ oz. tacks. A special hammer made of $\frac{1}{2}$ in. round steel and tempered is used to drive into and remove the tacks from the board. One end of the hammer is turned over at right angles to the length so that the end is $\frac{3}{4}$ in. from the inner face; the other end is straight and sharpened like a chisel. One end is used for driving

and the other for removing the tacks. The whole is about $6\frac{1}{2}$ in. long. The hammer is magnetized at a dynamo and will pick up tacks so they do not need to be handled with the fingers. Place the tracing cloth on the board and empty a box of tacks on the tracing and tack the center of the four sides with two tacks each, stretching the tracing tight. Then stretch the tracing by working from the center of the sides to the corners, placing a tack every two or three inches. This gives a perfectly smooth surface to work upon, and the tacks do not interfere with the sliding of the T-square. The tacks are removed with the chisel end of the hammer, taking up one tack after another.

Data on Handling Cast Iron Pipe Culverts.—Mr. John C. Sesser, Engineer of Construction, C. B. & Q. Ry., gives the following data on the cost of unloading, hauling and placing cast iron pipe. In 1905 that railroad on its extension from Centralia, Ill., to Herrin, used for its culverts ordinary cast iron pipes up to a size of 48 ins. in diameter. The contract for handling the pipe was let to a contractor at 75 cts. per ton per mile for the unloading and hauling and \$2.00 per ton for placing. A careful record was kept of all labor employed in handling this pipe, and from these data the following results were obtained:

Number of tons of pipe handled...	591
Cost per ton for unloading from flat and gondola cars, per ton	\$0.33
Average ton miles	32.74
Average miles hauled	3.82
Cost of unloading per ton mile....	\$0.09
Cost of hauling per ton mile, per ton	0.44
Cost per ton mile for unloading and hauling	0.53
Cost per ton for laying.....	0.55
Cost per ton per culvert in place..	2.39

The greatest distance the pipe was hauled was about 10 miles. From the data obtained it was deduced that: The cost per ton for unloading the pipe is the same regardless of size; that the cost of laying pipe per ton, for pipe under 30 ins. in diameter, is about 30% more than for pipe over 30 ins. in diameter. As a matter of fact it costs about twice as much per ton to lay 18-in. pipe as it does to lay 48-in. pipe.

Storage Magazines on the Isthmus of Panama.—Two new stations for the storage of explosives are to be constructed on the Isthmus of Panama. Each station will comprise a dynamite magazine with a capacity of 300 tons, a detonator house and a house for a watchman. Hollow concrete blocks 12 ins. thick will be the material used in the walls of the magazines and detonator houses. Tests have demonstrated, states the Canal Record, that this material is proof against a stray bullet and yet not

so hard or tough as to become a missile in case of an explosion, as it will disintegrate like brick. A 3-in. layer of concrete reinforced with old Belgian rails and waterproofed will form the roof, which is to serve the double purpose of keeping the explosives dry and cool. The floor will be a 3-in. layer of concrete, on top of which 2-in. planks will be laid loose. Lightning rods will protect these buildings. The dynamite magazines will be 112 ft. long, 48 ft. wide, and 9 ft. high inside. The roof will be supported by the walls and by posts from 12 to 14 ft. apart. It will be very flat, the pitch from the center to the walls being only 2 ft. 3 ins. in 24 ft. Two wooden doors, 7 ft. 9 ins. by 4 ft., cased in sheet iron, will open in the front; and two windows, 1 ft. by 18 ins., on each end of the building, 5 ft. 6 ins. above the floor, will supply light. Ventilation will be provided by air flues opening near the roof. The interior will be one large room in which 300 tons of dynamite can be stored in boxes piled not more than 7 high. The detonator houses will be of the same construction as the magazines except that they will have a double roof consisting of a ceiling of reinforced concrete and a wooden roof covered with corrugated iron. They will be 33 ft. 6 ins. long, by 17 ft. 3 ins. wide, and 10 ft. high inside. In one of the narrow ends will be a door 7 ft. by 4 ft., and opposite it a small iron window.

The engineer in charge of the Pathfinder Dam has submitted cost data on quarrying and cutting 5,567 sq. ft. of face stones, consisting of hard coarse-grained granite, for use in the dam. According to the July Reclamation Record the cost report shows a unit labor cost of \$0.91 per square foot and a unit supply cost of \$0.16 per square foot, making the total cost for labor and supplies of \$1.07 per square foot. The face stones penetrate an average of three feet into the dam, making a total cost, therefore, per cubic yard, of \$9.63. The cost data given do not include plant charges and cost of steel, oil and blacksmith coal. The work was done in October, 1907, and February, 1908. The average rate of wages paid was comparatively high.

An agreement has been reached between the Chinese government and the British-Chinese corporation by which the latter is to raise a loan of \$7,300,000 to be devoted to the construction of the Shanghai-Hangchow-Ningpo railway. The terminus of the line will be connected with that of the Shanghai-Nanking railway in Shanghai or its vicinity, whence it will run to Hangchow and Ningpo, via Fungchingtsun, Kiatingfu, Hushu, Hangchowfu, and Kiangkau. The road is to be completed within three years.

LETTERS TO THE EDITORS.

Sizes of Catalogs and a Comment on "Follow-Up" Letters.

Sirs: ENGINEERING CONTRACTING of June 10 contains several letters on the subject of sizes of catalogs, and on arrangements for filing the same. Some years since the Master Car Builders' Association adopted standard sizes for catalogs, as follows: $3\frac{1}{2} \times 6$ ins., 6×9 ins., and 9×12 ins. A couple of years since I fitted up my office, and arranged for filing catalogs of these sizes. I also supplied myself with binders for these sizes, opening on both the side and end.

Since that time, as far as I am concerned, those manufacturers adopting freak sizes have been at a disadvantage. I find it hard to keep track of their catalogs, and at times have been compelled to use an article which was not as well liked as another, simply because the catalog of the other was lost.

Now I would like to mention another matter which has become an almost intolerable nuisance to a busy man. I refer to the modern "follow-up" system. I have been pestered for two years by the maker of a certain machine and by a printing house, although I am not the man to whom the latter should send queries. They have been replied to three times that when the matter was "live" they would be informed. Then comes, a month later, "Not having heard," and then in a week "We have no answer to ours of," etc., and then a letter with a stamped envelope and a request to "Reply to ours of," etc. I think buyers should form a league, and bind themselves not to buy a single thing from those who run these afflictions.

Consulting Engineer.

Pine Bluff, Ark., June 17, 1908.

The Cost of Engineering in the U. S. Reclamation Service.

Sirs: This office is in receipt of your letter of June 11 requesting information on the subject of engineering costs on reclamation projects given in percentages of the total costs thereon. As you are aware, the Reclamation Service has a number of projects under construction, none of which are fully completed. It is therefore impossible to state either the total cost of the project or the percentage of engineering charges against it.

Relative to the features of the work, these are of such varying character as make the engineering charges against them also of varying amount. If the items of the various features on the project are considered still wider variations in the engineering charges, of course, will be encountered. Some of the features of the projects under construction have been completed, but in many cases the total engineering charges that would accrue to these features due to general engineering work on the project have not yet been distributed, mak-

ing the charges against them somewhat less than they would be on the completion of the work.

Referring to the Truckee-Carson Project, Nevada, the construction engineering charges on the main canal and structures average about 3 per cent, ranging for the different divisions from 2.2 to 4.1 per cent. Similar charges on the distributing canals show 4.5 per cent. The engineering percentage for the laterals on this project is 4.3 per cent.

The engineering charges for Division C on the Bufort-Trenton Project are 3 per cent of the total cost. This Division consists principally of the construction of a pressure pipe and appurtenances connected therewith. The construction engineering charges on the settling basin for this project are 2.4 per cent. These data will give you something of an idea of the construction engineering charges on some of the projects of the service. At the present time it is impossible, however, to state what the total engineering charges of these features will be in percentages of the total costs upon completion of the projects.

Very truly yours,

A. P. DAVIS,
Chief Engineer.

Washington, D. C., June 13, 1908.

Standard Sizes for Drawings and Specifications.

Sirs: I note with pleasure that the letter of Mr. Henry E. Baker, in a recent issue, has brought out a number of answers, showing that there is some interest in the matter of uniform sizes of catalogues, blank forms and maps.

I do not like the 9×12 size advocated by Mr. W. M. Dollar for shop detail drawings. This size should be, say $8\frac{1}{2} \times 10\frac{1}{2}$ in., which is a letter size. Usually drawings of this kind are accompanied by written instructions, and for convenience of folding in with the letter, should be the same size. This advantage is fully recognized by many engineers and is in more or less use. This also applies to small sketch maps as well, and needs no further argument for its adoption.

I would also like to see a uniform size for specifications. The U. S. Reclamation Service, under Director F. H. Newell, is to be congratulated for its efforts in this direction.

Their specifications are printed in book form, using the uniform size of $8 \times 10\frac{1}{2}$ in.

All blank forms are also of this size, and for this reason readily adjust themselves to the vertical system of filing.

In this connection, blank forms should only be printed on one side, and on tough, semi-transparent paper. When made out in india ink copies by blue printing can readily be made. An ideal system for blank forms (for engineering work) is to have rulings for different classes of work, for clearing, grubbing, excavation, embankment, lumber, timber, piles, concrete, stone

masonry, steel, etc. In making up monthly estimates, the sheets for the particular kind of work are used (as many as necessary) and then numbered and assembled, followed by a summary sheet or sheets as the case may be. The whole estimate fastened together and always kept flat. When mailed this should be done in large envelopes to prevent folding. All reports should be made out on multiple sheets (say $8\frac{1}{2} \times 10\frac{1}{2}$ in.) and in many cases it is desirable to preserve them in loose leaf binders. This is easily accomplished by punching holes (standard distances) along the left-hand edge, a margin being left for this purpose.

The whole idea is copied from that of a book, where pages are properly assembled for convenience of use.

The whole difficulty is that this subject hardly even receives serious attention or study, and this accounts for the many slipshod methods in use. Yours truly,

EMILE LOW, M. Am. Soc. C. E.,

606 Ashland Ave., Buffalo, N. Y.

June 12, 1908.

Annual Convention of the American Society of Civil Engineers.

The 44th annual convention of the American Society of Civil Engineers was held June 22-26 at Denver, Colo. The attendance was good—the published list showing about 380 names—and there were some later arrivals. As was natural, the majority in attendance were from the Mississippi valley and further west.

A special train over the "Burlington" left Chicago about noon June 21, arrived at Denver about 6 p. m. of Monday, and carried over 100 from the east and about Chicago. That Monday evening there was an informal reception, with dancing later, at "The Adams" hotel, which served to introduce the members and their families from the different sections to each other.

The next day—Tuesday—the regular program began with a meeting in the Senate chamber of the Capitol, called to order about 10 a. m. by Mr. Jaycox of Denver, chairman of the local committee of arrangements, who introduced the Hon. H. A. Buchtel, Governor of Colorado, who gave an address of welcome to the society. This was followed by an address of welcome from the Hon. Robt. W. Speer, Mayor of Denver.

President Chas. Macdonald of the society then gave the annual address to the society—a scholarly and interesting paper.

The afternoon of that day was occupied by an extended trip by trolley, through and about the city—"Seeing Denver."

At the evening meetings of June 24 and 25 there were an illustrated lecture by F. H. Newell on "Water Storage and Distribution" and a talk by Geo. G. Anderson on "Irrigation." There was also a session devoted to a discussion on "Maintenance of Macadam and Other Roads." The remaining time was devoted largely to excursions and entertainments of various sorts.

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are—First, to inform civil engineers and contractors of the articles and papers of merit that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

- American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.
American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.
American Engineer and R. R. Journal (Am. Engr. & R. R. J.), New York, N. Y.; m; 7x10 in.; 20 cts.
American Gas Light Journal (Am. G. L. J.), New York, N. Y.; w; 10x13 in.; 10 cts.
American Institute of Electrical Engineers Proceedings (Am. I. of E. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.
American Society of Civil Engineers Proceedings (Am. Soc. C. E. Proc.), New York, N. Y.; m; 4x7 in.; 75 cts.
American Society of Mechanical Engineers Proceedings (Am. Soc. M. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
Annales des Ponts et Chaussées (An. P. & C.), Paris, France; m.
Architects and Builders Journal (Arch. & Bldrs. J.), Baltimore, Md.; m; 9x12 in.; 20 cts.
Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
International Railway Congress Bulletin (Int. Ry. Cong. Bul.), Brussels; m; 50 cts.
California Journal of Technology (Cal. J. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x19 in.; 20 cts.
Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
Canadian Mining Journal (Can. Min. J.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
Canadian Municipal Journal (Can. Mun. J.), Montreal, Que.; m; 6½x10 in.; 10 cts.
Canadian Society of Civil Engineers Proceedings (Can. Soc. C. E. Proc.), Montreal; m; 4x7 in.; 50 cts.
Carpenter and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
Cassier's Magazine (Cas. Mag.), New York, N. Y.; m; 5x8 in.; 25 cts.
Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
Cement Age (Cem. Age), New York, N. Y.; m; 4x7 in.; 10 cts.
Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
Electric Railway Journal (Elec. Ry. J.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electric Traction Weekly (Elec. Trac. Wkly), Cleveland, O.; w; 7x10 in.; 10 cts.
Engineer (Engr. Lon.), London, England; w; 4x11 in.
Engineer (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Engineer (Eng.), London, England; w; 8x11 in.
Engineers' Club of Philadelphia Proceedings (Engr.' Club, Phila., Proc.), Philadelphia; qr; 4x7 in.; 25 cts.
Engineering-Contracting (Engr.-Contr.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Engineering Digest (Eng. Dig.), New York, N. Y.; m; 5x8 in.; 20 cts.
Engineering and Mining Journal (Eng & Min. J.), New York, N. Y.; w; 7x10 in.; 15 cts.
Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.
Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
Le Genie Civil Paris, France; w.
Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.
Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
Industrial World (Ind. Wld.), Pittsburgh, Pa.; w; 7x10 in.; 10 cts.
Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; \$1.
Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.
Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
Iron Trade Review (Iron T. Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.
Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
Journal of Electricity, Power and Gas (Jl. Elec. P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.
Mining and Scientific Press (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Modern Machinery (Mod. Mch.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Municipal Journal and Engineer (Mun. J. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.
Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 in.; 15 cts.
Power and Engineer (Pwr. & Engr.), New York; N. Y.; m; 7x10 in.; 20 cts.
Railway Age Gazette (R. R. Age. Gaz.), New York; w; 8x11 in.; 15 cts.
Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Roadmaster and Foreman (Rd. & For.), Chicago; 7x10 in.; 10 cts.
Rock Products (Rk. Prod.), Chicago, Ill.; bi-w; 9x11 in.; 10 cts.
Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr; 4x7 in.; 50 cts.
Schweizerische Bauzeitung, Zurich; w.
Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
Sibley Journal of Engineering (Sib. J. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.
Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.
U. S. Department of Agriculture Bulletin (Dept. Agr. Bul.), Washington, D. C.; 4x7 in.
U. S. Geological Survey Bulletin (Geo. Surv. Bul.), Washington, D. C.; 4x7 in.
Waterproofing and Fireproofing (W. P. & F. P.), New York, N. Y.; m; 5x8 in.; 10 cts.
Zeitschrift d. Oest. Ing. u. Arch. Ver. Vienna; w.
Zeitschrift d. Ver. Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Brick or Concrete as Foundation for Brick Pavement. Can. Engr., June 5, 1908; 1½ pp.

Gives report of Prof. I. O. Baker on series of tests made to determine whether or not it was practicable to advocate the use of a layer of brick with grout filled joints instead of the usual concrete foundation for pavements. Prof. Baker concludes:

"The brick beam referred to at the beginning of this report, made with standard grout, has a modulus of rupture of 607 lbs. per sq. in., which is 4 times (exactly 4.05) as much as the assumed average for the modulus of rupture of concrete; therefore, such a brick beam 3 ins. deep will carry as much load as the ordinary 6-in. concrete beam, and a brick beam 3½ ins. deep will carry 1.4 times as much as a concrete beam 6 ins. deep, and a brick beam 4 ins. deep will carry 1.8 times as much as a concrete beam 6 ins. deep. Further, the beams with the richer grout gave a modulus of rupture of 650 lbs. per sq. in., and hence such a brick beam will carry 8 per cent more load, respectively, than the beams just mentioned."

The Effect of Motors on Roads. By Douglas Mackenzie, Surveyor, June 5, 1908; 8½ pp.

A paper read before the Incorporated Association of Automobile Engineers. It treats of means of remedying certain defects in the design of motor vehicles which tend to injure the roads upon which they run. The nature of injuries to roads are taken under four heads: (1) Suction due to bad road material; (2) slip due to imperfect adhesion; (3) crushing due to insufficient area of support; (4) horizontal rotary movement due to steering or turning. The article also contains a paper by Col. R. E. Crompton, entitled "Notes on Wheel Diameters."

Hints on Fillers for Brick and Block Pavement. By C. G. Atwater, Eng.-Contr., June 10, 1908; 1 p.

Brings out some interesting points regarding the use of the pitch filler for brick and block pavement.

Road Improvement in New Jersey During 1907. Gd. Rds. Mag., June, 1908; 5 pp.

The matter in the article is taken from the 14th Annual Report of the State Commissioner of Public Roads. It contains among other matter some data on experiments with dust preventives, and the construction of marsh roads.

Macadam Roads. Gd. Rds. Mag., June, 1908; 2½ pp.

A paper by Walter W. Crosby, Chief Engineer Maryland Geological Survey, read before the Engineers' Club of Baltimore. The paper is general in character.

Motor Traffic as It Affects Municipalities. Gd. Rds. Mag., June, 1908; 4½ pp.

The matter in the article is taken from a paper by A. J. Jackson, read before the Manchester, England, Association of Students of the Institution of Civil Engineers. It treats of the problems resulting from motor traffic, which now confront municipal and road engineers. Descriptions of the construction of tar macadam roads are included in the article.

Government Experiments for Dust Prevention. Gd. Rds. Mag., June, 1908; 4 pp.

Gives data on experiments conducted by the U. S. Office of Public Roads, on the use of calcium chloride as a dust preventive; also contains account of Government experiments with oil and road asphalt. The matter is taken from a report of the U. S. Office of Public Roads.

Data on Tarvia Road Treatment in New York State and Tar Macadam Work in Canada. Eng.-Contr., June 3, 1908; 3 pp.

The article describes the methods of road treatment with tarvia employed at several points in New York State, and gives some data as to the cost of the work. Tar macadam work at Ottawa, Toronto, and Hamill-

ton, Ont., are also briefly described, and estimates are given on the cost of constructing a mile of tar macadam road, under Massachusetts conditions.

Methods of Dragging Earth Roads. Eng.-Contr., June 3, 1908; ¾ p.

Illustrates and describes methods of dragging earth roads by means of split-log drag, and plank drag.

Data on Macadam Road Construction at Easton, Pa. Eng.-Contr., June 10, 1908; ¾ p.

Gives cost of constructing several macadam streets at Easton, Pa.

A Cost Keeping System for Street Improvement Work. Eng.-Contr., June 10, 1908; 1½ pp.

Describes the set of blanks used by a contracting firm for keeping cost records of its paving work. Reproductions of the blanks are shown.

Transportation of Ashes and Rubbish in Philadelphia. Eng. Rec., June 20, 1908; ½ p.

Tells of the system lately installed in lower part of Philadelphia of carrying ashes and rubbish at night on the electric lines of the city. The material is collected in carts and wagons and at a dumping station loaded into the cars and hauled to the dumps outside of the city.

SEWERS.

Method and Cost of Building a Pipe Sewer Through Quicksands, Excavating the Ground with a Pump Showing Remarkable Economy. Eng.-Contr., June 3, 1908; 1½ pp.

Describes a novel method of sewer construction in quicksand, using a centrifugal pump for excavating and back filling. Methods of timbering and sinking foundation piles are described and detailed costs of the work are given.

Sewage Purification Works of the State Agricultural School, St. Anthony Park, Minn. By F. H. Bass. Eng. News, June 25, 1908; 1½ pp.

Gives plans, sections and views of sewage disposal plant for domestic sewage and describes construction and general conditions of operation.

Cost of Shallow and Deep Sewer Trenches. By J. G. Palmer. Eng. News, June 25, 1908; ½ p.

Describes character of work and gives detail costs of \$20 ft. of trench averaging 8.7 ft. deep and including four manholes.

The Weston-Salem Intercepting Sewer. By J. N. Ambler. Eng. News, June 25, 1908; 2½ pp.

Describes reconstruction of sewer 3,800 ft. and the cleaning of 2,200 ft. of a sewer which had become badly obstructed. Methods of construction and cleaning are described and general cost figures of the work are given.

Data on Sewage Purification at Providence, R. I. Eng.-Contr., June 17, 1908; ½ p.

A brief description with some cost data on the sewage disposal work at Providence.

The Design of a Sewer. By Frank R. Durham. Surveyor, May 29, 1908; 11 pp.

A continuation of an article begun in the May 22 issue of The Surveyor. It treats of the salient features of the design of a sewer. Numerous illustrations are given.

Havant Main Drainage. Surveyor, June 12, 1908; 4 pp.

An illustrated article describing the new main drainage system of Havant, England. An interesting feature of this system is the ingenious design of the pumping plant.

Chemical Precipitation v. Septic Tanks. The Surveyor, June 12, 1908; 2 pp.

A paper read by Joshua Bolton, Manager and Chemist to the Corporation of Hleywood, before the Association of Managers of Sewage Disposal Work. For experimental purposes the works at Hleywood were divided into two portions, one portion being

READY IN JULY

ROAD PRESERVATION
AND
DUST PREVENTION

By WILLIAM PIERSON JUDSON,
Author of "City Roads and Pavements."

Cloth, 6 x 9 ins., 150 pages, illustrated.

DESCRIPTION.

The preservation of surface and the prevention of dust on macadamized roads form the problem now to be solved by engineers charged with the maintenance of the many thousands of miles of broken stone roads which have been built throughout Europe during the past century and in certain of the United States during the past decade.

Preservation of, and dust prevention on, existing roads are the matters which are the most urgent, and road builders have been working and experimenting to these ends with results which are shown in this book.

CONTENTS.

Road Dust; Its Control and Prevention.
Origin. Limestone dust. Motor-car effects, as stated by Institution of Civil Engineers (of Great Britain); by the U. S. Office of Public Roads; by the Massachusetts Highway Commission; by the Massachusetts Highway Association; by the Department of Roads and Bridges of France. Need of Maintenance. Conditions, and methods of prevention, in England; in France; in the United States.

Moiature.
Water as a dust preventive. Sea-water. Calcium chloride: origin; methods of use; details; results; cost. Akonla. Lymanite. Fitzsimmons Patent dust-layer. Conclusions.

Oil Emulsions.
Summary. Various oils used. Objections. Methods. Cok's emulsion; Westramite, in England; in United States, in France, and in Germany. Westramite 2. Place oil. Crocogenit. Apulvite. Sandisize. Crompold D. Dustolite. Terraclia. Pulvicide. Emeinite. Hahaite. Rapidite. Conclusions. Mechanical emulsifier.

Oils.
Summary. Crude Petroleum: of the United States, Pennsylvania, Ohio, California, Texas, Kentucky, Indian Territory; of Russia; of Austria; of Borneo. Residual. Asphaltic. Slow distillation. Pipe line for California oil. Causes of failures. History: first use. Oil on stone roads: at Cranston, R. I.; at Liverpool, England; at Sydney, Australia; at Jackson, Tenn.; at Pasadena, Cal.; at Bayonne, N. J.; at Chicago, Ill.; at Beverly, Mass.; at Newton, Mass.; New York. Oiled earth and sand roads; in California; in Eastern States. Substitutes for California asphaltic oils. Methods: Petrolithic; Rolling tamper. Cheap rural oiled roads. Oiled gravel roads. Oiled broken stone roads. Repairs of oiled roads. Asphaltolene. Asphaltine.

Coal-Tar Preparations.
Summary. Refined tar; Heating kettles; uniformity. Opinions: of Massachusetts Highway Commission; of Thos. Aiken, M. I. C. E.; of French road-engineers; of Logan Waller Page; of Charles W. Ross. Methods: Success dependent upon four conditions. Failures and their reasons. History. Tar-spraying machines. Competitive trials. Quality: Importance; characteristics; tests; uniformity. Tarvia "A." Clare's patent Tar-Compo. Methods. Cleaning and scraping; heating; spreading; screenings; finishing; cost. Tarvia "B." or cold treatment: Sprinkling; cost. Tarvia on Massachusetts roads: in Parks, at Lynn, at Weymouth; at Newton. Penetration. On Rhode Island roads: at Tiverton. Conclusions. Appliances: "White" machine.

Tar-Spraying Machines.
"Aiken's patent pneumatic Tar-sprayer": Description; method; on new macadam; cost; use on old surface; details; cost. The "Tarspra": Description; method. "Lassally-Johnston patent Tar road-binder": Description; method; results in France and England. "Thwaite anti road-dust machine": Description; method; cost. "Tarmacer": Description; method. Conclusions.

Tar Macadam.
Summary. Various forms. History. Hand mixing. Machine mixing. Methods: in England, at Grimsby, at Nottingham, at Gainsborough. Tarmac: at Newark, England; objections; methods; extent of use; comparative costs. Tarred crushed stone. Klads of rock; methods; surfacing old roads; poor method; comparative costs at seven places in England. The "Gladwell" system. Summary. Methods; cost; opinion. Tar-macadam in United States and Canada: Summary; opinion. Methods and costs: in Rhode Island; in Canada: Comparative costs in Massachusetts; improved methods.

Rock Asphalt Macadam.
Summary. Sources of supply. Limitations of use. Methods: in Little Rock, Arkansas; details; cost. In Bowling Green, Kentucky; Description of material; Methods; results; cost. Use in "Gladwell" system.

Bitolithic Pavement.
Summary. Characteristics. Opinions: Of George W. Tillson, president of American Society of Municipal Improvements; of Massachusetts Highway Commission; of Chicago South Park Commission; expressed in the 1902 and the 1906 editions of "City Roads and Pavements." History; growth; extent; imitations; methods. Semi-portable paving plants: Description; views and key. Cost.

THE ENGINEERING NEWS BOOK DEPT.
220 Broadway, New York City

worked as open septic tanks, and the other on chemical precipitation. The paper gives the results of tests.

Special Features of the Sewage Pumping Machinery, Reinforced Concrete Rising Main and Travis System Sewage Tanks in Progress at Norwich. By Arthur E. Collins. Surveyor, June 5, 1908; 10 pp.

As its title implies, this article is a description of the special features of the sewer system of Norwich, England. The reinforced concrete rising main is $2\frac{1}{2}$ miles long and 36 in. in diameter. It is being constructed on the "Bona" system. The article also contains a description of the Travis system of hydrolytic sewage tanks and the principles and practice of their operation. The discussion of the article is given in the June 12 issue of The Surveyor.

WATER-WORKS AND HYDRAULICS.

Test of Air Lift Pumping Plant and Experimental Studies of Air Lift Pumps. Eng. News, June 18, 1908; 2½ pp.

Abstracts results of two sets of tests of air lift pumps, one the test of the air lift pumping plant at Atlantic City, N. J., and the others a series of studies made by the Westinghouse Air Brake Co., at Wilmerding, Pa.

Determination of the Area of Waterway Required. By E. A. Harrison. Can. Engr., June 5, 1908; 1½ pp.

Argues the advantage of care in determining the area of waterway for culverts and outlines the four possible methods with comparisons of their practical value. Several area of waterway formulas are given and their merits discussed.

Experiments on Various Types of Fire Hydrants. By C. L. Newcomb. Eng.-Contr., June 24, 1908; 5 pp.

Gives results of tests made to determine:

1. The loss of pressure due to the friction of water in the hydrant, the total loss being subdivided into barrel loss and nozzle loss.
2. The discharging capacity of open hydrants.

Failure of Wrought Iron Standpipe at Watertown, N. Y., from Pitting. By H. J. Morrison. Eng. News, June 25, 1908; 1½ pp.

Describes structure and character of failure with illustrations and full statement of the extent, character and location of the pitting which had weakened the plates.

Comparison of Formulas for Computation of Stream Discharge. By J. C. Stevens.

Examines the several formulas for computing stream discharge with the view to the adoption of one as a standard which will give reliable results under all field conditions.

The Clogging and Cleaning of Water Mains. Eng. Rec., June 6, 1908; ½ p.

Condensed from a written discussion by Mr. Alex. Potter of a paper on the subject, before the American Water-works Association, in which some hints on cleaning tuberculated pipes are given, with some costs on doing the work. This article is of interest to water works engineers.

Water Rate Statistics. Min. Jl. & Eng., June 17, 1908; 3½ pp.

Abstract of a paper by Dow R. Gwynn, read before the American Water Works Association. The article includes tables showing the water rates charged in 1907 in 375 cities.

Springfield's Proposed Reservoir. Min. Jl. & Engr., June 10, 1908; 1½ pp.

Gives some details of the design of the large covered reservoir to be built for the city of Springfield, Mass. A feature of this reservoir will be the extensive use of rock embankment.

Direct Air Pressure Pumping. Can. Engr., June 12, 1908; 2½ pp.

Describes some tests made on a driven well to determine the amount of water

raised, air required and other necessary data relative to pumping by direct air pressure.

Sanitary Patrol of Water Sheds. By Theodore Horton. Eng. Rec., June 20, 1908; 1½ pp.

A paper reprinted from the Monthly Bulletin of the New York State Department of Health makes various suggestions as to the inspection of water sheds, the need and care with which it should be done. Lays down a number of general rules for carrying on a thorough inspection.

New Uses for Steel. By R. B. Woodworth. Proc. Ry. Club of Pittsburgh, April, 1908; 40 pp.

A history of sheet piling, both wooden and steel, is given and comment is made on the inefficiency of wooden sheet piles, which made engineers look for a substitute, which they found in steel. Later it developed that in most cases the steel piles were found to be cheaper. Cross sections of various patented piles are shown and the author, who is Chief Engineer of the Carnegie Steel Co., discusses the most successful shaped pile from the general standpoint of the user, and also of the service that can be obtained from it.

Power Capacity of a Running Stream Without Storage. By Prof. Wm. G. Raymond. Jl. N. E. W. W. Assoc., June, 1908; 9 pp.

A general discussion of the amount of flow of the stream to depend upon in designing a power plant. A number of things to be avoided are pointed out, and many suggestions are given as to methods to pursue in obtaining and plotting data regarding the stream flow, with its use for plant designing.

The Management of the Typhoid Fever Epidemic at Watertown, N. Y., in 1904. By George A. Soper. Jl. N. E. W. W. Assoc., June, 1908; 76 pp.

A detail description of this epidemic of fever, and of the management of the water supply of Watertown and the sewerage systems of the towns located in the drainage area of the Black River, from which source the water supply for Watertown was taken. The fever in the town was caused by the polluted water taken from the river. There is much valuable information on the subject, likewise a number of good suggestions as to the prevention of like epidemics.

Filter Operations, Investigations for Additional Supply and Construction of New Filter at Lawrence, Mass. By Morris Knowles, M. F. Collins and Arthur D. Marble. Jl. N. E. W. W. Assoc., June, 1908; 43 pp.

An article in which much information is given in regard to the Lawrence filters. A general description is given of the filters. Tables showing water pumped through them, with hours of pumping, etc., are presented, and much data as to scraping the filter beds. The results of filtration are shown. The new filters are described and the methods of construction illustrated. This article is of value to those interested in water filtration.

RIVERS, HARBORS AND CANALS.

Application of the Reservoir System to the Improvement of the Ohio River. By W. D. Conner and M. O. Leighton. Eng. News, June 11, 1908; 4½ pp.

This discussion comprises a paper by Capt. Conner, U. S. A., criticizing the reservoir project for controlling Ohio River floods, and of an answer to these criticisms by Mr. Leighton.

Effect of Conservation of Flow in the Ohio Basin on Floods in the Lower Mississippi. By A. H. Horton. Eng. News, June 11, 1908; 2 pp.

This paper is the result of an attempt to determine from a review of actual records

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3. Logarithms of the sine, tang., cotang., and cosine for each minute of the quadrant, with proportional parts for seconds.
4. Natural Functions.

Of these, the table of log. functions is, of course, the most important one, and special attention is called to a new arrangement, the advantage of which consists mainly in relieving the eye of the great mass of figures concentrated on the pages of the old arrangement; it also permits the use of larger type and clearer distribution of same.

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On account of the increase in size, by the addition of 133 pages of new material, the price of the complete volume in this edition has been advanced from \$3.00 to \$3.50; the new material in separate volume will be sold at \$1.50.

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THE ENGINEERING NEWS
BOOK DEPARTMENT

220 Broadway, New York City

the contribution made by the Ohio basin to Mississippi floods, and the effect produced on the latter by flood conservation in the former. The following facts are shown:

(1) That the Missouri basin, by reason of its great area of flat country, is slow-spilling and floods therein do not rise with rapidity sufficient to gorge the channel of the Lower Mississippi.

(2) That the Upper Mississippi basin, although subject to more rapid fluctuations in flow than the Missouri, is very much smaller than the latter and could not originate floods of capacity sufficient to gorge the Lower Mississippi.

(3) That the Ohio basin discharges at maximum flow 50 per cent more water than the Missouri and Upper Mississippi combined, and as the basin is a quick-spilling one, it practically alone is the cause of floods in the Lower Mississippi.

(4) That inasmuch as it has been shown to be possible to reduce floods in the Ohio, the same means will also reduce to a point well within the capacity of the Lower Mississippi channel all the floods that are likely to visit that channel.

The Lock in the Charles River Dam, Boston. By Walton H. Sears. Eng. Rec., June 13, 1908. 2 pp.

Describes the lock built for this project, and illustrates machine for operating the gates. The lock has in it an ice run to admit of the ice passing the lock.

An Extensive Cofferdam of Steel Sheet Piling. Eng. Rec., June 13, 1908; 1 p.

Describes and illustrates the work being done with steel sheet piles on the ship lock in connection with the Black Rock Channel improvement at Buffalo, N. Y. Shows method of connecting piles.

An Electrically Operated Dredge. Eng. Rec., June 6, 1908; 1½ pp.

A description of a 20-in. suction dredge being used in dredging the harbor of Los Angeles, Cal., operated by electricity. States certain advantages obtained by the use of this form of power. The electricity is transmitted from a plant built for commercial purposes.

Increase in Dredging Prices. Can. Engr., June 12, 1908; ¾ p.

A table showing the increase in price over 1907 of dredging for the Canadian Government at various points in Ontario and Quebec.

An Excess Curve of Quantities for Trapezoidal Canal Sections. By Harry E. Soverson. Eng.-Contr., June 17, 1908; 1 p.

This article is reprinted from the University of Colorado Journal of Engineering. Tells of a formula used and diagram based on the formula for determining the depth of cutting necessary to build the two-side embankments of a canal. This formula and diagram have been used by the U. S. Reclamation Service in making paper locations of canal work in ground that is rough, as well as where the surface is of a fairly uniform slope. It has been a great help to the engineers of the Service.

The Proper Shape for Rock Drill Bits. By D. J. O'Rourke. Eng.-Contr., June 24, 1908; 2 pp.

As the title of the article implies, the shape of drill bits is discussed, and illustrations show various shapes for use in different rocks, but in addition the author gives much information and makes numerous excellent suggestions as to the blacksmith's work and his ability, the sharpening of bits, the length of the up-set and the gorge. A practical article that will be found of use by every engineer and contractor engaged in rock-drilling.

RAILWAYS.

Moisture in the Atmosphere and Its Effect on the Operation of Compressed Air Machin-

"I would have given \$1,000.00 for this book a year ago."—W. H. BURK, Knoxville, Tenn.

"FIELD SYSTEM"

By FRANK B. GILBRETH, M. Am. Soc. M. E.

WHO THE AUTHOR IS.—Frank B. Gilbreth is the contractor who has made the "cost-plus-a-fixed-sum-contract" famous. In order to handle contract work scattered all over North America, Mr. Gilbreth found it necessary to develop a system whereby his foremen would execute work properly, promptly and economically. The code of rules and instructions to his foremen, and the printed forms for their reports, were bound in book form, and this book Mr. Gilbreth called his "Field System." Mr. Gilbreth's contracts have covered the widest possible range. Railways, canals, dams, factories, office buildings, whole industrial towns, are among the works that he has executed.

WHY ENGINEERS SHOULD STUDY "FIELD SYSTEM."—Every engineer should know how to manage men, for, whether he confines himself to purely professional work or enters into business of executing construction work, his ambition should be to direct the men under him in a manner that will secure the greatest possible efficiency. A revolution in the art of managing men is now in progress. Direct personal supervision was once deemed essential. To-day, however, "system" is fast supplanting personal supervision. By "system" we mean printed or written directions for employees to follow, and daily reports that show what the employees have done. System of this sort has recently been extended to the field survey work of the U. S. Geological Survey. While Gilbreth's "Field System" is not a system for the management of surveys, for example, it is rich in suggestions that can be applied in the management of any kind of field work, whether employees are engaged in surveying or in construction. Its rules and methods are applicable to office work, in so far as the principles involved are concerned. The book, in brief, is a treatise on the science of managing men by system. No engineer who aims to be more than a subordinate can afford not to have this treatise, written by a man who is an acknowledged adept in managing men.

Hundreds of engineers have gone into the contracting business during the past few years, and there is room for thousands more. But if they are to succeed in any great measure, it must be by the intelligent application of system and cost analysis. Gilbreth's "Field System" does not cover the whole field, nor was it written to cover it, but it does cover a very important part of the field, and a part upon which practically nothing has ever been written.

WHY CONTRACTORS SHOULD HAVE "FIELD SYSTEM."—Mr. Gilbreth has done in contracting what Mr. W. L. Douglas and Mr. Marshall Field have done in the mercantile field. He has taken a class of work involving endless detail, and has reduced the handling of these details to a system by virtue of which economy in construction and celerity in performance are secured, regardless of place or men. Every one has heard the expression, "one-shovel contractor," meaning a contractor capable of managing only one steam shovel at a time. The "one-shovel contractor" is the antithesis of the contractor having a system. The "one-shovel contractor" receives daily reports, it is true, but his reporters are his two eyes. The "one-shovel contractor" has a code of instructions for his men, it is true, but his ready tongue is the only leaf of a code bound between the cover of two jaws. The day of the "one-shovel contractor"

is not yet gone entirely, but it will pass rapidly away. Every contractor should have a field system of his own, embodying his own experiences and covering his own necessities, but in the developing of such a field system no contractor can afford not to study the work of Mr. Gilbreth.

COPIES OF "FIELD SYSTEM" STOLEN.—When it became generally known that Mr. Gilbreth had supplied his foreman and superintendents with printed instructions, copies of the book were bribed from his employees, and photographed page by page, from cover to cover. Other copies were "lost," and thus made way with entirely. Huge salaries were used to hire away Mr. Gilbreth's superintendents, for the purpose of getting not only their trained services, but for their knowledge of the contents of the "Field System."

MAKING THE BOOK PUBLIC.—Mr. Gilbreth's action in making public his "Field System" in its entirety is without precedent in the world of business. It is an act that puts contracting on the high professional level of civil engineering. The civil engineer discloses his method of designing a structure, his purpose being to assist other engineers in doing as well. In the interest of scientific advancement the engineer places on record what he has found to be economic or effective. In the same spirit—we may call it the modern American spirit—Mr. Gilbreth has permitted publication of his private code of instructions to his men—his "Field System." He believes that contractors, and, indeed, all professional business men, will become far more efficient as managers of men if such systems as this are disclosed. He believes that in the general rise of efficiency that will occur all those engaged in business will share. He believes that those who are best fitted to be leaders will remain leaders. Character, experience and ability will have the same relative weight as ever. In these beliefs every broad-minded man ought to concur.

China is a nation that worships "trade secrets." It is a nation of industrial mutes. Their arts and their manufactures are taught by father to son, and zealously guarded. There has been no pyramiding of improvements upon one original invention as a base. The Chinese do not lack inventive ability. They are merely cursed by the curse of secretiveness. Their industries are plastered with signs of "No admittance," and are mummified in consequence. In striking contrast with the Chinese method is the American method. Our doctors, or engineers and our men of science generally have never concealed their discoveries or their improvements. Latterly our business men have shown a recognition of the truth of the general proposition that it pays the individual to share his discoveries with the rest of his fellows. Such generosity, in the final analysis, is simply an enlightened selfishness. The publishers of Gilbreth's "Field System" urgently request other contractors and business men to come forward with their systems, and put them permanently on record. Let business men generally adopt the altruistic policy that actuates professional men, and in its prosperity America will soon rise as far above its present level as it now stands above the level of the Chinese Empire.

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The Danger of Alkali Soils to Under-ground Concrete Structures.

The report of the destruction of under-ground cement work at Great Falls, Mont., by alkali salts contained in the soil is perhaps the first official publication on a subject which has during the last year or so interested a great many engineers doing concrete work in the so called alkali dis-

tricts of the west. A correspondent in another column urges that engineers refrain from accepting without question the claim that alkali soils are destructive to Portland cement products and suggests the hope that at Great Falls the damage may be found chargeable to the cement used rather than to the soil conditions described. Were the experience at Great Falls the only one recorded our correspondent's remarks would have more force. It is, however, only one of a number of records, and we fear that the evidence of the destructive effect of alkali soils on concrete and mortar must be accepted as sound. In this connection we quote an interesting extract from a paper read at the recent meeting of the American Society for Testing Materials by Mr. J. Y. Jewett of the U. S. Reclamation Service.

Mr. Jewett states that within the last year city engineers and the engineers of the service have noticed the deterioration of concrete work at about the soil line in alkali soils. The action appears much like that of concrete in sea water. No particular investigation of the phenomenon has been made by the engineers of the service beyond a general study, but the evidence is such that Mr. Jewett takes occasion to say:

"The following suggestions are offered as practical measures to be taken by those who are engaged in construction work or who are considering the taking up of such work in these sections of the country:

"(1) An investigation of the character and composition of the 'alkali' in any district where construction work is contemplated.

"(2) A study of the materials available for use as concrete aggregates, and involving the question, in case such are not altogether satisfactory, of obtaining a more satisfactory supply from a distance.

"(3) Consideration of the best methods to be employed in any given case for producing an impervious concrete.

"(4) The above assumes that the cement to be used is of a reliable brand and of such quality as will pass the standard tests of this society, as the use of any special cement, such as the 'iron ore' cement above mentioned, is probably out of the question for these regions at the present time.

"It is not the purpose of this paper to attempt to discourage in any way the rapidly growing use of cement in its manifold forms of application in these regions, but rather with the belief that 'forewarned is forearmed' by calling attention to the danger which exists and to provide for the taking of steps to avert the same."

It is clear that a careful study should be made of the effect of alkali salts on cement and cement products.

An Interesting Example of Small Tunnel Work.

In another column of this issue we give the cost of constructing a small tunnel to carry cables under a narrow navigable river. Seemingly this work presents little

that should make it worthy of mention. In reality the article is unique. It so happens that nearly a year ago the editors of Engineering-Contracting became aware of this work, then proposed, through a request for references to any cost figures of tunnel construction under similar physical conditions. A pretty careful search of the records failed to bring much satisfaction. Apparently no figures even approximately applicable to the case had been published. We understand that the engineers of the work experienced a similar lack of success from their own researches, which were quite extensive. The article is unique in being one of the very first to give costs of the type of structure represented.

Mention of the above circumstances is important for the lesson it teaches. It is not the exceptional structure about which the engineer has to search far and wide for information, but it is the structure of ordinary character. We believe that every construction engineer and constructor will agree with this statement. Technical literature is crowded with examples of the large and unusual things in engineering work; the ordinary things in size and character are rarely described. This is very largely the fault of the engineers and constructors themselves. Only recently in seeking information regarding the cost of a small job of bridge work the reply was that "being just an ordinary job no costs were kept."

This reply indicates quite truly the ideas of many construction engineers and constructors. We believe that it is wholly wrong. The costs in detail of a Fifth Bridge are interesting, but the costs in detail of half a dozen highway bridges of one-tenth the span would be vastly more useful, and the man who would collect and make known the latter would be doing the more useful work. Right here we have the purpose of this talk. It is not necessary for the young engineer to wait until he is associated with some work of unusual magnitude and character before he presents an article to a technical paper or an engineering society. Such works never lack writers to exploit them, but the ordinary structure which is built in the hundreds does lack writers to discuss and analyze the construction problems involved. In particular they lack writers to make known the methods and cost of doing the work.

This journal has made it a policy to give the ordinary structure adequate attention. Indeed our chief trouble has been to get the necessary data. Time and again our inquiry has been met with the statement that "being an ordinary structure, no careful records were kept." On the other hand, no request for methods and cost data is more common than for the thousand and one small works which ordinarily make up the practice of the engineer.

At the close of 1906 there were 24,097 miles of railway in India.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Recent Experiences with Reinforced Concrete and Concrete Block Buildings in Fires.

The ability of concrete buildings to withstand damage by fire has been demonstrated in some measure by several recent fires. At the convention of the National Fire Protection Association the committee on concrete for building construction presented reports of these fires and discussed the lessons taught by them in a manner which should interest concrete men. We extract the following paragraphs from the report:

"A most interesting fire occurred Feb. 18, 1908, at Dayton, Ohio, in the new factory of the Dayton Motor Car Co. and was reported at some length in the 'Quarterly' of the National Fire Protection Association, from which the following is quoted:

"The building is the newly constructed monolithic reinforced concrete construction, six stories high. It adjoined and communicated through unprotected openings with a five story brick building of ordinary construction. The concrete building was of pier and curtain-wall construction. Piers in basement 25x25 ins. and spaced 22 ft. c. to c.; bays supported by same class of girders spaced 7 ft. c. to c., 9x11 ins.; beams from piers, 12x17 ins. The piers decrease in cross section until at roof (or sixth floor) they are 12x12 ins., except under foundation for sprinkler tank, where they are 19½x19½ ins. Roof of same class of construction, but with lighter structural members. Floors of monolithic, reinforced concrete construction, supported on the beams and girders. Wood floor on first attached to wood nailing strips laid in concrete. Same devices used for giving initial supports to wood running boards to attach electrical wires.

"Between each outside pier, both in exterior and area walls, there is a 4-in. concrete curtain wall extending about 3 ft. from floor. On this rest ordinary light wood sash and thin glass, making a very large area of this inferior class of construction.

"One large open elevator and one stairway at same point. The fourth floor, where the fire started, was occupied as upholstering and trimming, also storage of motor cars. Fifth floor was painting department and this floor was practically vacant. Fire was discovered by outsider at 12:15 a. m. and was first noticed about midway on the west side. The occupancy made a hot quick fire which spread rapidly throughout this

portion of the floor and through the unprotected openings into the brick building, which latter was practically destroyed except the walls. The fire department helped keep the fire from spreading, and also helped confine it largely to the fourth floor of the concrete building.

"The only floor on which fire gained a foothold was the fourth, where it originated. The mass of combustible material therein was sufficient in one section to spoil the concrete covering on one pier and numerous girders. The concrete has fallen off some of the girders on lower edges, exposing the metal reinforcement. The action of the heat has calcined the concrete to such an extent as to make some of the girders defective against another attack. Our inspectors do not consider the integrity of the supports impaired against ability to sustain load, but only against fire. There was scarcely 5/7 in. of concrete about the bottom of the reinforcing members, which is totally inadequate and not in accord with best practices.

"The heat caused about 2 ins. of the concrete floor to disintegrate. In one instance, directly above the hottest part of the fire, the action extended to and through the ceiling of fourth floor. The mass of combustible material on which flames fed was comparatively small; had the fire been long sustained, as in a general conflagration, the concrete structure would have failed and one floor would have wrecked the one beneath.

"Water seeped through the concrete floor and about the risers for both the steam heating and the sprinkler system and damaged stock more or less on every floor. The sewer becoming clogged, water stood 10 ins. deep in the basement and wood bodies of motor cars were somewhat damaged.

"The damage to this building was adjusted at 8 per cent of its sound value, which, by the way, was a definitely known quantity, as the building was quite new. The building was far from being fireproof in the proper sense of the term, owing to its large ordinary glass walls and unprotected floor openings, and also its inadequate insulation of steel reinforcement. That the fire did not spread throughout the house and destroy its entire contents is due to the efforts of the fire department rather than the character of the construction. Still it must be conceded that the concrete itself stood the test very well indeed, especially in view of the fact that the ordinary building

adjoining was much more seriously damaged by the same fire and under the same fire department protection.

"Another fire of universal interest occurred Dec. 13, 1907, in the Huyler building, 131 East 18th St., New York. Here concrete made a very favorable showing, and the value of protected stair and elevator shafts and of wired glass in outside windows, as a protection against the spreading of fire from one floor to another was demonstrated. The building was about 50x80 ft., ten stories high, of steel frame with 6-in. concrete floors. The sides of beams and girders were protected by 2 to 3 ins. of concrete, and the lower flanges by 1 in. of plaster keyed on by wire. Steel columns were covered by 2-in. terra cotta blocks, and the entire interior coated with about 1 in. of ordinary plaster. Floor surfaces were of decorative tile 6x6x½ ins. Stairs and elevators were inclosed in good tile walls with fire doors on each story. Front windows were of ordinary glass, but those on the side and rear were of wired glass in metal frames.

"The fire started about 7:10 p. m. from unknown cause in the ninth story, used chiefly for the storage of empty cartons and paper stock in considerable quantities. It was in the vicinity of the front stair shaft, but did not spread through this shaft (as is usual) on account of its being cut off from the rooms. It soon extended toward the rear of the room and attracted the attention of employes who attempted to use private hose, and the fire department responded to alarm by the thermostat system. The department carried the hose streams up the stairway and through the adjoining building and eventually extinguished the fire after most of the contents of the ninth story were ruined. The plaster was all knocked or burned off the walls and ceilings, and all the windows (both ordinary and wired glass) were broken out. There was no fire damage on other floors, except that the wired glass windows in the tenth story rear were badly cracked from flames lapping up from below, and the stone sills of these windows were badly spalled. These windows, however, kept the fire out of the upper floor and undoubtedly prevented a serious loss to contents in that story. There was no damage to steel work and very little to tile or concrete covering of same, and the loss to the building as a whole was adjusted at about 4 per cent of value, being chiefly confined to destruction of wood trim, plastering, painting and tile floor surface.

"Ordinarily a fire starting among inflammable materials as high up as the ninth story results in a serious loss. In this case the fact that the fire was discovered and the department called early and that each story of the building was quite effectually cut off from the others, and the structure was non-inflammable itself, reduced the damage to both building and contents to a small fraction of what it might have been under less favorable conditions.

"On May 27, 1907, a fire occurred in Merritt Bros.' factory at Camden, N. J., which in a building of ordinary construction would doubtless have resulted disastrously. It proved, under the circumstances, to be chiefly a demonstration of the fire resistive quality of the building. It is a five-story structure for the manufacture of metal clothes closets for factories. The columns, beams, floors and roof are of heavy type reinforced concrete, the mixture being 1:2½:5, using small size crushed trap rock. The walls are of brick carried on a concrete frame. The fifth story was occupied for painting and drying. In the corner of the room were two wooden gas heated drying ovens approximately 7x10x8 ft. and along the side of the room next to this were a number of smaller ovens, all of metal construction. These two wooden ovens had been filled with freshly painted metal to be dried. An employe endeavored to light the gas under the oven and he either dropped his torch or the burners failed to ignite properly so that the paint and drip pans close by caught fire and the flames promptly extended into the oven.

"The fire lasted from ½ to ¾ hour, practically burned up the wooden ovens and some other light inflammable materials close by. The flames did not extend very far into the room, however, though there was enough heat to melt out the soldered metal frames of the wire glass monitors on the roof a little to one side of the ovens, and melt the links on two fire doors, 40 to 50 ft. away. The concrete columns and ceiling in the immediate vicinity of the fire showed some cracks, but no material injury, and absolutely no repairs of any sort were made to the concrete after the fire, the only repairs being to the above mentioned wire glass window frames.

"On May 30, 1907, a fire destroyed the factory of the Waverly Paper Box Board Co., Waverly, N. J., and afforded a test of concrete. The entire plant had plain 12-in. solid concrete walls one story high. The floors were also of concrete, but the roof was wood and was entirely consumed, with the combustible contents of the buildings. The walls seem to have been of fairly good gravel concrete and suffered some damage from cracking and dehydration of the cement at the surface, but as a whole may be said to have resisted this fire about as well as brick would have done; they have since been used in the rebuilding of the factory.

"Only three fires in buildings of concrete block construction have been reported to your committee which seem to warrant special mention.

"One occurred in Nashville, Tenn., in the summer of 1907. This was a four story building, 50x170 ft., with walls of two-piece concrete blocks and a wooden joisted interior, occupied throughout by a retail furniture store. The top story and attic were completely burned out, but the damage to concrete block walls was nominal and easily repaired. The test could not be

termed severe, but the blocks made a very creditable showing under the circumstances.

"The second fire occurred Dec. 9, 1907, at Anderson, Ind., in a three story building just completed, but not occupied. The house was fitted up for an old peoples' home. It had ordinary single piece hollow concrete block walls and wooden interior, and was of fairly good size, containing 40 living rooms, office, dining rooms, etc. The entire interior was burned out, but the walls stood with very little damage, except at the top and around windows, and have been used in reconstruction.

"The third fire occurred at Murfreesboro, Tenn., April 29, 1908, in a basement and two story building, 60x115 ft. It was occupied in basement and first story for the storage of hay, grain, feed, cotton and hardware; the second story as a roller skating rink. The walls were 10-in. single-piece hollow blocks; floors and roof of ordinary joist construction. Fire started in the first story and burned from 9:30 p. m. till midnight. The blocks appear to have been of rather poor quality, made with crushed stone aggregate and quite porous. All walls above the first floor fell, the rear and front walls being completely down, with the exception of several lower courses of blocks of rear wall. The only weight carried by the walls was the dead weight of the second floor and roof, at the time of the fire the second floor (skating rink) being unoccupied.

"Beyond considerable chipping and small amount of spalling, the limestone foundation which formed the basement wall is not badly injured, and with repairs may be used again. The total damage to the building and contents is estimated at \$10,000.

"Unequal expansion between the outer and inner shells of blocks was clearly demonstrated by the rear wall, where the bond between the outer and inner shells of blocks was cracked continuously almost the entire length of the remaining wall.

"This was undoubtedly a long, hot fire and furnished a more severe test of the blocks than the other two fires mentioned above. It seems to justify the following opinion of this committee expressed in last year's report:

"Well made blocks are suitable for small buildings, where no high temperatures or long continued fires are to be expected, but the hollow form in which they are made absolutely precludes their being classed as highly fire resistive or suitable for fire walls, or for any buildings which may be subjected to severe fire."

On the last working day in May there were in the service of the Isthmian Canal Commission on the isthmus, and actually at work 25,881 persons, not including 7,052 persons employed by the Panama Railroad Company. Of the number employed by the Commission 20,584 were in the department of Construction and Engineering, and of this number 3,686 were on the gold roll.

A Discussion of Metal and Wood Forms for Concrete Constructions.

Form construction is always an interesting subject to the contractor for concrete work. The following comments by Mr. L. C. Wason, President Aberthaw Construction Co., an experienced concrete contractor, will therefore be interesting. These remarks formed a portion of the discussion on form construction at the last annual convention of the National Cement Users' Association and are as follows:

There is a great field for research and inventive genius in the production of cheap, durable, forms sufficiently flexible for many different uses, as the cost of this part of the work is at present one of the greatest handicaps to the reduction of the cost and the more general use of concrete construction. The writer has used metal forms to some extent and has observed their use by other contractors. If sheet metal is placed on a wooden back or on a metal stiffening frame, there is danger of its becoming dented, bent, or otherwise defaced so as to give an imperfect surface to the concrete, and if the metal covering is sufficiently thick and strong to resist damage it is too heavy and expensive for general use. Moreover, such forms are not flexible enough to be used for various purposes. The use of heavy cast-iron molds, as proposed by Mr. Edison, is far more expensive still. Therefore, up to date, wood has proved to be the most economical and flexible in the way of being changed from one use to another of anything which the writer has yet seen, and his study has been concentrated on the most effective and economical use of lumber. When a sheet metal form becomes dented it is usually cheaper to throw the covering away and start new than to straighten and reuse that which is bent. With the rough, careless class of mechanics called carpenters, which is the only possible kind to get for concrete forms, there is great danger of a rapid deterioration in the value of the material. Thoroughly good mechanics—those who are capable of doing a nice job of carpentry—cannot be induced to work on this class of construction. The quality of these rough carpenters is also becoming poorer, usually on account of the trade union's restriction to the employment of apprentices. Any man who can buy a few tools and use a saw and hammer can hire out as a carpenter. He is so poor that he is constantly discharged and after a considerable time of practicing on one job after another may show a little intelligence, but he is a very inferior workman at best.

In considering the cost of construction as a whole it is as likely to be governed by the cost of the forms as by the cost of the concrete. For illustration, in the cost of columns, although they are made so as to be reduced in size as easily as possible, this is somewhat expensive in labor, and after they are reduced the girders and beams which meet at a column are too

short and have to be spliced out, which adds to the cost, and these costs are likely to exceed that which can be saved in concrete. It is therefore more economical to run the columns one size through the full height of a low building or to reduce the size only twice or at most three times in the height of a high building. For instance, the actual cost of labor (without regard to wastage of lumber), in reducing columns from 16 ins. to 12 ins. on a certain job, amounted to \$5.70, whereas the cost of the concrete saved by the reduction was \$2.30. In the writer's office a set of plans in pamphlet form has been compiled for standard forms for all kinds of work, and where special framing is required plans are made for these special cases, and in spite of this care and study the above figures represent actual experience. Therefore, in designing and handling form work the cost of labor is the principal item to be considered. The opinion has been expressed that forms could be cheapened by the use of common and rough lumber instead of a fairly good grade of dressed lumber. The fact that it is almost universal to use a good grade of dressed stock would seem to disprove the above statement. The cost of dressing varies according to the mill from \$1.50 to \$4.00 per 1,000 B. M. for planing four sides. The price of second-grade hemlock and spruce differs but little from that which has small sound knots and is free from wind shakes or large season cracks, and such lumber works so much easier as to cut down the labor cost more than the equivalent of the difference in cost of material. Some builders use $\frac{3}{8}$ -in. stock, others $1\frac{1}{2}$ -in., and some 2-in. stock. The thicker lumber will stand the wear and tear longer than the light and can therefore be used so many more times than the thin that it is more economical in the long run if the work in hand is large enough so that the forms can be used several times without delaying the rapid progress of the work. With planed stock tighter joints can be obtained between boards, which prevents leakage of the fine materials and weakening and roughening the surface, and the boards are of even thickness so that a fairly good surface is obtained which needs little treatment after the forms are removed except where an ornamental appearance is especially desired. If rough lumber is used, in order to get even a passable surface finish, considerable labor must be spent upon dressing the concrete after the forms are removed, and this must be done by mechanics. If a cement finisher, who is in no sense a plasterer, is used, and his wages are 45 cts. or 50 cts. an hour, only a fair job can be obtained. If plasterers are used their pay is 60 cts. per hour and the job is properly finished, but in either case the cost is greater than the cost of planing lumber and of using a good quality. Rough lumber can only be used economically in work which is never exposed to view or where the looks is no object whatever.

Cost of Two Small Concrete Structures for an Irrigation Canal.

The following costs are taken from the Reclamation Record for June:

"Cost analyses have been received for building two concrete structures by force account on the Truckee-Carson project (Nevada) during the period from August to November, 1907. These structures are located on the line at points where the capacity of the canal is 163 second feet; the one located at station 125+00 is a wasteway and the other, located at station 182+55, is a drop with turnout on each side of the canal. The concrete was mixed in the proportions of 1:2:1, and in the drop with turnouts a small amount (200 lbs.) of reinforcing steel was used, the cost of which is included in the cost of concrete in the table below. The sand for the concrete was

COST OF TWO CONCRETE STRUCTURES IN TRUCKEE-CARSON PROJECT.

Class of work.	Structure at Station.			Structure at Station.		
	182+55			125+00		
	Quantity.	Unit cost.	Total.	Quantity.	Unit cost.	Total.
Trench excavation	43.0	\$1.84	\$79.17	40.6	\$1.29	\$52.04
Concrete	32.0	12.39	396.44	34.0	14.08	478.82
Forms (per cu. yd. concrete)	32.0	5.26	168.38	34.0	3.22	109.61
Placing forms, cu. yds.	4,016.0	25.41	.....	3,170.0	21.84	.....
Paving, cu. yds.	180.5	2.88	520.37	174.0	2.69	467.86
Riprap, cu. yds.	18.0	.72	12.91	47.0	.68	31.85
Backfill, ft. B.M.	40.0	1.00	29.99	40.0	.75	30.20
Flashboards, sq. yds.	27	.....	15.07	12	.....	19.34
Cast-iron guides, sq. yds.	8	.....	108.08	4	.....	18.90
Angles, cu. yds.	2	.....	5.02	..	.....	.....
Total productive cost.			\$1,345.43			\$1,208.62
Construction survey			15.34			13.96
Non-productive account			226.52			211.32
General expense			278.66			155.22
Total costs			\$1,865.95			\$1,589.12

hauled from $\frac{1}{4}$ to $\frac{1}{2}$ mile, crushed rock from 7 to 8 miles and cement from 10 to 11 miles. The paving consists of a 4-in. layer of crushed rock overlaid with a 6-in. layer of stones, the interstices being filled with crushed rock. For the wasteway 21 sq. yds. of the paving and for the other structure 26 sq. yds. were grouted, the cost of which is included in the unit and total costs of paving tabulated below. The riprap consists of a 6-in. layer of stones roughly placed along the banks of the canal above the structures. The unit and total costs tabulated below for the different classes of work include the cost of labor, except labor of foremen, and the cost of materials and supplies. Labor of foremen is included in what is called the non-productive account. The wages paid were, concrete men \$2.50 per day, pavers, \$2.75 per day. The accompanying table shows the distribution of costs."

Press reports announce that plans have been filed with the Building Department of New York City for a 62 floor office building. The plans provide for the main building to be 34 stories high, the roof being 489 ft. above Broadway. Above this is to be a square tower of 28 stories capped with a cupola, the tower and cupola adding 420 ft. more to the total height. The plans were prepared by D. H. Burnham & Co., acting for the Equitable Life Assurance Society.

LETTERS TO THE EDITORS. Destruction of Portland Cement by Alkali.

Sirs: I was considerably interested in an article about the destruction of cement mortar by alkali salts in your issue of June 24. While I do not wish to intrude upon the ideas of men better able and more competent than myself, yet from this distance it seems to me that they have jumped to conclusions without thorough investigation.

Before passing final judgment it seems to me they should have tried some other kind or kinds of cement and noted the effect of alkali on them.

It is just barely possible that alkali would not effect some other cement, and it is quite probable that that particular cement was of little or no account when it was put

in the work. The fact that it was given the usual tests before using proves nothing. A dishonest manufacturer can get around every test with the possible exception of the chemical test. He may add an excess of lime, magnesia or sulphur or all three and the cement will give high tests, but in a short time deterioration sets in and the work goes to pieces.

One brand of cement whose base is blast furnace slag gives very high tests, yet some of it owing to the presence of sulphur goes to pieces in a short time. I hope the people in charge of those tests will locate the true cause of this failure in cement. In the meantime let us withhold final judgment until further tests have been made.

Very truly,

C. W. PARKER.

328 Drake ave., Chicago, Ill.

June 28, 1908.

Los Angeles county, California, will hold an election on July 30 to vote on issuing \$3,500,000 of bonds for the improvement of roads.

The Board of Water Supply of New York City is calling for bids for the construction of another portion of the Catskill aqueduct. The section consists of about $6\frac{1}{2}$ miles of plain concrete conduit, known as cut-and-cover aqueduct, 17 ft. high by 17 ft. 6 ins. wide, and about 13 ft. 4 ins. wide on the hydraulic gradient.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Nine Examples of the Cost of Wheel Scraper Work, with Comments on Handling Scraper Gangs.

In this article we give nine examples of the cost of wheel scraper work. One thing of interest regarding these examples is that in each case a No. 2½ wheeler was used. Most records of costs of wheel scraper work that have been published have either been of No. 2 or No. 3 scrapers.

The cost records were kept in great detail. In every case the work done was in grading a railroad bed.

The wages paid for a 10 hr. day were as follows:

Foreman	\$3.00
Scraper team and driver.....	4.75
4 horse plow team and 2 men.....	9.20
3 horse snatch team and 1 man.....	6.00
Loaders	1.60
Dump men.....	1.50
Water boy.....	1.00

The grading was done in the fall of the year with good weather prevailing. The material excavated was red clay subsoil with some sand mixed with it. The teams were hired, the contractor furnishing the scrapers, plows, etc.

Table 1 gives the length of the lead in feet, the lead being the distance in a straight line from the center of mass in the excavation to the center of mass of the embankment. The length of the haul follows the lead, the haul being the average distance traveled by the scraper in going to and from the dump, including the distance traveled in turning at both ends of the haul. The next item is the number of miles traveled per day by a scraper. The fourth item in the table gives the number of cubic yards moved per scraper day, while the next item is the number of cubic yards moved per team per day. Item No. 6 gives the average number of scrapers worked in a gang or crew; it consists of a foreman, a 4 horse plow, a 3 horse snatch team, 2 loaders, 2 dump men, a water boy and the given number of wheeled scrapers. The last item gives the average yardage moved per day by the gang.

In table 2 the cost of the work is given, showing the cost of each item separately.

These costs do not include any allowance for plant used or maintenance and repairs to plant.

In handling scrapers, contractors and engineers seem to have paid but little attention to the number of scrapers to operate a gang for the various lengths of lead, deciding on the number to use from impressions gained through their experience in operating scrapers.

It will be noticed that the leads in the examples given varied from 260 to 1,100 ft. For the short leads 5 scrapers were used. On a 260 ft. lead each scraper moved 31 cu. yds. per day, while on a 300 ft. lead each scraper moved 32 cu. yds. 5 scrapers still being operated in the gang.

These records are not given either as ideal records or as economical examples of scraper work, but, being actual and accurate records of work done, are published in order to make an analysis and such comparisons as may be of benefit to those interested in scraper work.

It would seem that the distance covered

tional trips of a scraper during the day, which would have meant an increase of 10 cu. yds. per day per scraper. The increase may have been a little more, as the 5 scrapers set a lazy pace, while the 4 scrapers coming to the snatch team regularly would have been the cue for the whole gang to have worked with greater snap and vim. This increased yardage would have meant that the gang would have averaged 176 cu. yds. per day, thus decreasing all the cost items somewhat.

The time lost waiting to be loaded in using 5 scrapers on a 300 ft. lead, where the haul amounted to 725 ft., is not as much as on the 260 ft. lead, the lost time being but ⅓ of a minute. This is a harder problem to solve, but it is possible to solve it. The cut or excavation, instead of being worked as a single piece of work with a load of 300 ft. and a haul of 725, must be divided into two pieces of work, so that one piece will have an increased haul over the 725 ft. and suited for a run of 5 scrapers, while

TABLE 1.											
Item	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
No. Headings.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.
1. Lead in ft.....	260	300	400	500	700	800	900	1300	1400	1500	1600
2. Haul in ft.....	600	725	1000	1100	1450	1650	1900	2700	2900	3100	3200
3. Distance traveled in miles.....	12	13	16.5	17.5	19	19.5	17	18	19	20	21
4. Cu. yds. moved per scraper.....	34	32	29	28	23	20.8	16	11.7	11.5	11.3	11.1
5. Cu. yds. moved per team.....	21	20	19	18	15.5	14	12	9	9	8.8	8.6
6. No. scrapers in gang.....	5	5	6	6	7	7	12	12	12	12	12
7. Av. cu. yds. moved per day.....	170	160	174	168	161	146	192	141	138	135	132

per day by each scraper in these two examples was much less than it should have been, as in other examples each scraper team covered more than 16 miles. Under these circumstances, if the foreman did not allow his men and teams to loaf, time must have been wasted by the scrapers in waiting to be loaded, thus showing that too many scrapers were worked in the run. This is evident for another reason. With a haul of 600 ft., with a team traveling at the rate of 200 ft. per min., which is not excessive even over such ground as a scraper is used upon, the scraper should make the

the other piece will have a decreased haul, one suited to 4 scrapers. In this manner, the scrapers employed can be worked all the time, and the maximum output obtained and the "hauls are equalized," as the contractors express it.

From example No. 3 it would seem that 6 scrapers were about the correct number for a 1,000 ft. haul, but in example No. 4 the snatch team had to wait on the scrapers. This was likewise the case with examples Nos. 5 and 6. In example No. 7 too many scrapers were worked in the gang, and the contrast between the number used with an

TABLE 2.											
Headings.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.
Foreman	\$0.017	\$0.017	\$0.017	\$0.017	\$0.020	\$0.015	\$0.015	\$0.021	\$0.023	\$0.023	\$0.023
Scraper	0.138	0.149	0.154	0.150	0.210	0.228	0.293	0.407	0.410	0.410	0.410
Plowing	0.052	0.052	0.050	0.051	0.056	0.062	0.046	0.065	0.070	0.070	0.070
Snatching	0.034	0.034	0.032	0.034	0.037	0.040	0.030	0.043	0.046	0.046	0.046
Loading	0.018	0.018	0.017	0.018	0.020	0.021	0.016	0.023	0.024	0.024	0.024
Dumping	0.016	0.017	0.016	0.017	0.018	0.020	0.015	0.021	0.023	0.023	0.023
Water boy	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.007	0.007	0.007	0.007
	\$0.281	\$0.293	\$0.301	\$0.313	\$0.365	\$0.397	\$0.420	\$0.588	\$0.603	\$0.603	\$0.603

round trip in 3 mins. It takes not over a minute to load a No. 2½ wheeled scraper under fair conditions, hence from the time the scraper leaves the cut to its return only 3 scrapers have been loaded, with the result that the scraper must wait a minute while the fifth scraper is being loaded.

From this it would seem that for a 260 ft. lead, 4 scrapers should be used instead of 5. This would have meant that the expenses of the gang would have been reduced \$4.75 and each scraper worked would have moved a greater yardage. Theoretically the time wasted in waiting to be loaded would have allowed of 30 addi-

800 ft. and 900 ft. lead is very striking.

Such records call attention to the inconsistencies that are bound to occur where a contractor manages his work without keeping detail records, and having such records properly tabulated and analyzed.

Again, in examples Nos. 8 and 9 not enough scrapers were moved.

It will be noticed that for the shorter hauls the increased cost due to adding 100 ft. to the lead, with wages as paid for this work, is about 1 ct. per cu. yd. When the leads are longer than 500 or 600 ft the costs increased much more than 1 ct. The ordinary price paid for overhaul in many

sections of the country in the past has been 1 ct. per cu. yd. for each 100 ft. of over-haul. For short free haul with low wages there may be, at times, a small profit at this price, but under most circumstances 1 ct. per cu. yd. per 100 ft. will hardly cover the cost of wheel scraper overhaul, especially if the free haul is 1,000 ft. Contractors should give this matter some study and see to it that their bids are such as net them a profit on each item. The writer knew of a contractor who bid an overhaul price of $2\frac{1}{2}$ cts., with a free haul of 1,500 ft., and even at this price there was no profit in the overhaul during the winter months.

The cost per cubic yard for plowing in Table 2 is high, when one takes into consideration that, even at the wages paid, earth should be loosened for about 3 cts., but this high cost is caused by the fact that the plow team was kept in the cut during the whole day, whether it was working or not. According to the nine examples, the plow loosened on an average 160 cu. yds. per day. A four horse plow can easily loosen from 300 to 400 cu. yds. per day, say 350 cu. yds. This would mean considerably less than 3 cts. per cu. yd. This shows the necessity of working two scraper gangs, wherever possible, close enough together so that one plow team can serve the two gangs. The saving thus effected will be enough to yield a nice profit on the work.

Two men were used to load the scrapers. For a small wheel scraper, one man is sufficient, and it is possible for one man to load a No. 2½ or No. 3 wheeler, but 2 men will do the work more efficiently, and they are needed when a 4 horse snatch team is used. Under most circumstances a 4 horse snatch team will do more economical work than a 3 horse snatch team. This phase of scraper work was discussed in *ENGINEERING CONTRACTING*, Aug. 28, 1907, p. 132.

In the examples here given two men were used to dump the scrapers. This is not necessary, as one man can easily learn to dump even the large size wheelers, without aid, and the only reason two men were used was on account of the labor market. Men were difficult to obtain, and to detail only one man to a dump meant a strike among the laborers. If only one man had been used the cost of dumping given would have been cut in half.

It will be noticed that the cost of the items of the work, other than the actual scraper cost, amount to from 30 to 60 per cent of the total cost, thus showing that the scraper must move from 50 to 100 per cent more earth than needed to show a profit on each scraper's work. It means to work the horses to the utmost, hence only the best horses or mules should be employed, and good care must be taken of them, or else they will soon grow stale in their work, and the amount being done will rapidly decrease.

Scraper work is very difficult to handle. It should move with clock like precision,

and, when anything occurs to interfere with this routine, money is wasted. This means that the man in charge must always be on the alert, and he should also be resourceful under trying circumstances. Close application and study of the job in hand will decrease the cost of the work. Indeed, too much study cannot be given to excavating earth with scrapers.

Cost of Excavating and Lining a Small Tunnel, with Shafts, Under a River.

BY CLARENCE MAYER.

The following costs relate to the excavating and lining of a comparatively small tunnel with corresponding shafts. The tunnel was built for the purpose of carrying cables under a river. Shafts were excavated on both sides of the river, one shaft being sunk perpendicularly to a depth of 84 ft. including a 4-ft. sump, while the other shaft

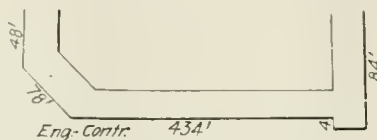


Fig. 1.

was sunk perpendicularly to a depth of 48 ft. and then sloped at an angle of about 45° for 78 ft. The diameter of the shafts was 7 ft. The length of the tunnel was 434 ft. and the width was 7 ft. A profile of the work is shown by Fig. 1, and Fig. 2 is a cross section of the tunnel.

Very little rock was encountered. The greater part of the excavation for shafts and tunnel was in hard clay. The shafts were excavated by means of hand labor, us-

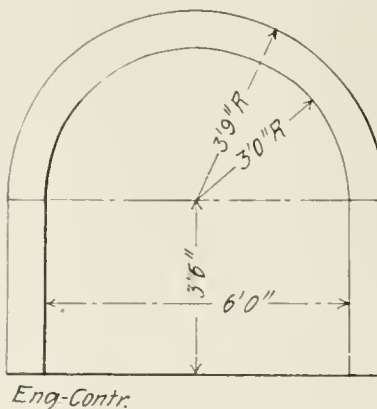


Fig. 2.

ing pick and shovel, and iron cylinders were used as a curbing. The excavated earth was hoisted in buckets and loaded into carts. The tunnel was excavated by hand labor, using mattock, pick and shovel, and the excavated earth was hauled to the shafts in wheelbarrows and hoisted in buckets.

The shafts and tunnel were lined with concrete, shafts and side walls of tunnel averaging 6 ins. in thickness and arch of tunnel averaging $6\frac{1}{2}$ ins. in thickness. The concrete was mixed in proportions of 1 part

American Portland cement, 3 parts sand and 5 parts stone.

The rate of wages paid on the work for a 9-hour day was as follows:

Foreman	\$1.50
Assistant foreman.....	3.50
Carpenters	3.50
Engineer on concrete mixer.....	3.00
Laborers	2.25
Teams	4.50

The work was done by contract, but the costs given below are the actual costs of the work, kept for the information of the contractor. The cost of the tunnel per lineal foot was:

Labor:	
Concrete lining	\$ 3.60
Excavating	4.70
Teaming	.38
Hoisting material, etc.....	.14
Lowering material, etc.....	.06
Arch centers (inc. moving forward) ..	.46
Backing, bracing and scaffolding.....	1.40

Total	\$10.74
Materials:	
Lumber	\$4.55
Incidental	.60
Concrete	2.43

Total	\$7.58
Total labor and materials.....	\$18.32

The cost of shafts per lineal foot was:

Labor:	
Excavating	\$ 6.50
Teaming	.24
Hoisting material, etc.....	.05
Lowering material, etc.....	.04
Concrete lining.....	2.50
Forms	1.00
Sheeting	1.50

Total	\$11.83
Materials:	
Lumber	\$6.00
Concrete	2.10
Incidental	.60

Total	\$8.70
Total labor and material.....	\$20.53

In the costs given above no charge has been made for plant, and the costs do not include office expenses of the contractor.

During the fiscal year 1906-7 the cost of coal on Italian railways amounted to 17 cents per train mile, against France's 10 cents.

The Department of Lock and Dam Construction on the Isthmian Canal has been abolished and in its place the Atlantic Division has been created. The Atlantic Division embraces all territory north of Iabernilla, in which work of the Construction and Engineering Department is being done. Major William L. Sibert has been designated Division Engineer of the Atlantic Division, with headquarters at Gatun

Cost of Engineering in Reservoir Construction and Legal Expenses in Condemning Land.

The building of dams and reservoirs for a water supply for New York city on the Croton watershed, the work in all cases being in charge of the Aqueduct Commission, has been done by contract. The engineering expenses for each project have thus been easily kept separate from the cost of construction. Likewise the legal expenses in obtaining the land needed for the reservoirs have been kept separate. We give these costs for the following reservoirs, the figures being compiled from the report of the Aqueduct Commission.

East Branch Reservoir.—Known officially as Double Reservoir "I," built during the years 1888-1893. The Sodom reservoir consists of a 500 ft. long masonry dam, 98 ft. high from the foundation and 78 ft. above the surface of the ground; an earthen dike 600 ft. long, 75 ft. high, with a masonry core wall; and a masonry overflow weir 500 ft. long. The Bog Brook reservoir consists of two earthen dams, one 1,310 ft. long and 60 ft. high and the other 1,956 ft. long and 24 ft. high, each with a masonry core wall. These two reservoirs, Sodom and Bog Brook, are connected by a tunnel 10 ft. in diameter and 1,778 ft. long, excavated through rock. The tunnel is lined with brick, backed with rubble masonry. By means of this tunnel one spillway was made to serve both reservoirs. These reservoirs are located near Brewster, Putnam Co., N. Y. They have a capacity of 9,643,000,000 gals.

The cost was as follows:

Construction	\$ 890,695.54
Engineering	161,550.18
Land	685,420.25
Legal expenses.....	243,991.78
Total	\$1,981,657.75

This shows a cost per million gallons of \$205.50. The engineering expenses were 15.3 per cent of the total cost of construction. The cost per acre of the 1,963 acres of land acquired was \$473.36 including the legal expenses. The legal expenses were 26 per cent of the total.

Carmel Reservoir.—Known as Reservoir "D," is located on the Croton River near Carmel, Putnam Co., N. Y., and was built during the years 1890 to 1898. The main dam has a length of 1,800 ft., of which 260 ft. is a masonry waste weir, flanked on either side by earthen dikes 65 ft. high with core walls of masonry. There is an auxiliary dam made of earth 720 ft. long and 45 ft. in height at the highest point, built with a masonry core wall. Capacity of the reservoir, 10,070,000,000 gals.

The cost was:

Construction	\$ 818,636.95
Engineering	155,668.68
Land	511,963.16
Legal expenses.....	180,603.94
Total	\$1,666,872.73

The cost per million gallons was \$165.53, the engineering expenses being 16 per cent of the cost of construction. The cost per acre for the 1,691 acres of land bought was \$409.56 including legal expense. The legal expense was 26 per cent of the total cost of the land.

Titicus Reservoir.—Known as Reservoir "M," situated near Purdy, Westchester Co., N. Y. It covers 725 acres, having a capacity of 7,167,000,000 gals. There is a masonry dam 334 ft. long, 135 ft. high above the foundation and 109 ft. above the surface of the ground. The masonry waste weir is 200 ft. long. On the north end of the dam is an earth dike 732 ft. long, while the one on the south end is 253 ft. in length, both with core walls. The cost of this reservoir was:

Construction	\$1,065,923.11
Engineering	103,291.80
Land	512,284.40
Legal expenses.....	116,303.89
Total	\$1,797,803.20

The cost per million gallons was \$236.89 and the engineering expenses were 9 per cent of the total construction cost. Including legal expenses the land cost \$607.28 per acre for 1,045 acres, the legal expenses being 18½ per cent of the total land cost.

Jerome Park Reservoir.—Located in the city of New York. Construction was commenced in 1895, and by Jan. 1, 1907, the reservoir was nearly completed. The western part, covering 94 acres with a capacity of 773,400,000 gals., was completed and filled with water. The eastern part has an area of 135 acres and a capacity of 1,130,000,000 gals. This part is not yet completed, work having been suspended on it. There is a retaining wall around the reservoir 10,000 ft. long and 5,000 ft. of embankment with a core wall of masonry. There are 7 gate houses, a number of outlets and other appurtenances. The cost up to Jan. 1, 1907, was:

Construction	\$5,794,987.68
Engineering	541,312.12
Land	2,997,344.63
Legal expenses.....	161,427.08
Total	\$9,493,071.51

Using the above figures the cost per million gallons of water is \$4,988.48. The engineering expenses are 8½ per cent of the cost of construction. The legal expenses were 5 per cent of the cost of the land.

Summary.—On these four jobs \$9,532,066.06 were spent on construction, of which 10 per cent was for engineering expenses. This includes all preparatory work of surveys, borings and tests, and the studies for the designs, which in dam and reservoir construction frequently are quite expensive, if this preliminary work is done properly, and the Aqueduct Commission has been very thorough in its work. The salaries paid to engineers in New York city by the city departments are a little higher than in most sections of the country, as living expenses are greater in New York than in

other cities. Another reason for the high percentage is that the length of the day worked on most of these jobs was only 8 hours.

The total cost of the land for these four reservoirs was \$5,409,339.13, there being 13 per cent of this for legal expenses in acquiring the land. This makes evident how poorly engineers are paid for their work as compared with the legal profession.

Some Records of Channeling, Drilling and Cableway Work.

In this work on the West Neebish channel, in the improvement of the St. Mary's River between Lake Superior and Lake Huron, the excavation was in hard compact Niagara limestone, weighing 4,600 lbs. per cu. yd. The total amount of rock excavated was 1,700,000 cu. yds. The depth of the cut varied from zero at the ends to 27 ft. in the center, with an average depth of 15 or 16 ft. The cut was 8,800 ft. long.

In order to make the sides of the cut smooth, channelers were used, there being one Sullivan Class "V" 7-in. channeler, which carried its own boiler and two 8-in. air channelers, made by the Ingersoll-Rand Co. More than 200,000 sq. ft. of wall were channelled. An average day's run for the machine was from 75 to 100 sq. ft., although on test runs, as much as 205 sq. ft. were cut by one machine. These machines were capable of cutting to a depth of 14 ft., but in most of the work done, the cut was put down in two lifts.

The cut was 300 ft. wide, and in blasting 150 ft. of the breast was shot at one time, allowing the steam shovels to work on one-half the cut, while the drills were at work on the other half. About thirty 34 rock drills were used. The holes put down were from 12 to 16 ft. deep. The holes were spaced in 4x6 ft., or 5x5 ft. squares. This close spacing was found necessary on account of the hardness and dense nature of the rock. The average work done by a drill per shift, both summer and winter, was from 40 to 60 ft., say 50 ft. Air hammer drills were used to drill top holes for breaking up large boulders. The drill holes were shot with dynamite, ¾ lb. (half 60 per cent and half 40 per cent) being used for each cubic yard of rock blasted.

Four 60-ton steam shovels, mounted on traction wheels with 30-in. tires, were used to load the muck into skips that were handled by four cableways, two having spans 1,100 ft. and two spans of 800 ft. each. The skips held 6 cu. yds. each, but loads as high as 18 tons, consisting of boulders of 7 or 8 cu. yds., were handled by the cable ways. An aerial dumping device was used on the cableways. One of these cableways handled 30,000 cu. yds. in a month, which was the best month's record for any single cableway. The best month's record for the four cableways was 88,000 cu. yds. of rock, or an average of 22,000 cu. yds. per cableway.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Some Experiments Upon the Beamlike Strength of a Brick Pavement.

Prof. Ira O. Baker, of the University of Illinois, is conducting a series of tests for the National Paving Brick Manufacturers' Association, on the strength of paving brick cemented together with the grout. The cemented bricks are tested like a beam, with the idea of using them as a foundation for street paving. We abstract the following from Prof. Baker's first report on the subject:

I made six beams about 30 ins. wide and 7 ft. long, using Terre Haute and Clinton (Indiana) brick, Chicago AA Portland cement, and ordinary building sand. In mixing and using the grout, I followed as nearly as I could the standard specifications of your association. In making the first beam the grout leaked out at the bottom of our experimental beam, and in the confusion resulting therefrom the grout was not kept properly stirred and consequently the results of the first beam are not satisfactory and have not been included in the comparisons to be made later. I then made three beams, using standard grout, which seemed to be reasonably satisfactory.

Your standard specifications for the grout were designed for a form of construction whose chief purpose was to protect the upper edges of the bricks in the pavement from chipping; but in the matter in hand the purpose of the grout is to give beamlike action to the pavement. For the first purpose the richest grout should be in the bottom of the joints. Therefore I made two beams, in which I used a grout composed of two volumes cement to one volume of sand from top to bottom. I hope to make another experiment in which I shall use rich grout at the bottom of the joint and the leaner grout at the top of the joint; but in the first experiment I thought it wiser to use the rich grout from top to bottom. It is almost certain that the leaner grout at the top of the joint will not decrease the strength of the beam, and it surely will decrease the cost of the construction.

Below are the results obtained from the six beams which I have thus far broken. The beams were supported at the bottom and loaded at the middle and all were tested when 33 days old:

Beam No.	Modulus of Rupture, Lbs. per Sq. In.
1 Standard grout.....	370.4
2 Standard grout.....	678.2
3 Standard grout.....	540.8
4 Standard grout.....	603.1
Average	607.4
5 Grout: 2 cement to 1 sand....	627.2
6 Grout: 2 cement to 1 sand....	672.4
Average	649.8

The modulus of rupture is the term used by engineers in expressing the strength of a beam. It may be defined to the laymen as the stress in pounds per square inch upon the outside fibre at the bottom of the middle of the beam.

Understanding that you desired these experiments made in order that you might determine whether or not it was practicable to advocate the use of a layer of brick with grout-filled joints instead of the usual concrete foundation for pavements, I presume it will be acceptable for me to offer some comparisons between the strength of such a brick beam and of a similar concrete beam.

I have examined engineering literature with a view of extracting for your benefit data on the modulus of rupture of concrete, but I have found such a variety of results that the best data I can find is far from satisfactory. The experiments vary because the tests were made with concrete of different ages and different degrees of wetness and stored in different ways, some in the air, some under damp sand, and some under water. Below are some of the most valuable results that I could find:

Authority.	Age when tested.....	Proportions— Cement.....	Proportions— Sand	Aggregate	Proportions.....	Modulus of rupture, lbs. per sq. in.....
Baker's, 28 days.....	1	1	2½	5	1:7½	144
Masonry, 28 days.....	1	1	3	5	1:8	88
Const., 28 days.....	1	1	2½	6	1:8½	81
Page 112v, 28 days.....	1	1	3	5	1:5	145
A.N. Talbot, 30 days.....	1	1	2	4	1:10	113
Falk (p. 147), 40 days	1	3	6	1:9	1:70	208
Average						137
Falk (p. 149), 128 days	1	3	5	1:8	1:196	196
Sabin, 1 year.....	1	3	7½	1:10½	204	
Falk (p. 146), 7½ years	1	2	4	1:6	296	
Falk (p. 146), 7½ years	1	3	5	1:8	228	

The above results are all that I can find in engineering literature with any reasonable expenditure of labor.

When I began to write this report I thought I had several results for natural cement, but apparently I have only one; namely, a result by Sabin for a 1-2-4 natural cement concrete tested at one year, which gives a strength of 159 lbs. per sq. in. From my general knowledge of natural cement, I am quite sure that this is unusually large, and I think it is safe to say that at a month the strength of natural cement concrete is not more than one-third of that of Portland cement concrete of the same proportions and age.

The above data for the strength of concrete are so varied that it is nearly im-

possible to draw any conclusion as to a representative average. I have tabulated the results in the order of the age when tested. Notice that the average modulus of rupture of the results in the table from 28 to 49 days is 137 lbs. per sq. in. I intended to break the brick beams when 28 days old, but an accident made it impossible to break the first beam until it was 33 days old; and as it was desirable to have all tested at the same age, all were tested when 33 days old. The mean age of the first seven results is 30 days. It is hardly correct to take averages this way, but for this purpose it is nearly correct to say that the average strength at 30 days is 137 lbs. per sq. in. I think this result is higher than will ever be attained in a pavement foundation, for you must remember that the above results are from carefully conducted laboratory experiments, while in practice the concrete is mixed by unskilled labor with the chief object of obtaining an economical result rather than the greatest possible strength.

Preliminary to making a comparison between the strength of the brick beam and a similar concrete beam, permit me to explain that the strength of a beam varies as the square of its depth, and therefore a beam 6 ins. deep will support 3½ times as much load as a similar 4-in. beam, and practically 3 times (exactly 2.95) as much as a 3½-in. beam, and 1 times as much as a 3-in. beam.

The brick beam referred to at the beginning of this report, made with standard grout, has a modulus of rupture of 607 lbs. per sq. in., which is 4 times (exactly 4.05) as much as the assumed average for the modulus of rupture of concrete; therefore such a brick beam 3 ins. deep will carry as much load as the ordinary 6-in. concrete beam, and a brick beam 3½ ins. deep will carry 1.4 times ($4.05 \div 2.95 = 1.4$) as much as a concrete beam 6 ins. deep, and a brick beam 4 ins. deep will carry 1.8 times ($4.05 \div 2.25 = 1.8$) as much as a concrete beam 6 ins. deep. Further, the beams with the richer grout gave a modulus of rupture of 650 lbs. per sq. in., and hence such a brick beam will carry 8 per cent more load respectively than the beams just mentioned.

The total mileage of steam railroads in the United States on December 31, 1907, according to Poor's Manual for 1908, was 228,128 miles, as against 222,766 miles on Dec. 31, 1906, an increase of 5,362 miles.

A recent Consular Report states that in a few streets in Constantinople there is a kind of concrete sidewalks, but these are not general; in fact, in some streets there are no sidewalks at all. Where an attempt has been made to make concrete sidewalks, sometimes little more than a yard or a half in width, the process used is quite primitive. A foundation of sand and pebble is laid, and this is cemented over about as the walls of a house are plastered. Before hardening a design is worked in.

Methods and Costs; Some Old; Some New.

Cost of Making House Connections.—The following data have been taken from statistics collected by a committee of the sanitary section of the Boston Society of Civil Engineers, and presented before that society on May 6 last. The data are for the year 1906:

	Size, inches	No. made during year	Lin. ft. laid during year	Av. cost per ft. of connections made
Arlington, Mass.	6	64	3,911	\$0.55
Everett, Mass.	6	106	4,420	.60
Fitchburg, Mass.	6	47	1,900	.40
Hyde Park, Mass.	6	123	6,026	.60
Lawrence, Mass.	6	176	6,026	.60
Martborough, Mass.	6	36	1,500	.42
New Bedford, Mass.	6	322	12,046	.48
Newton, Mass.	6	107	8,599	.65
Pawtucket, R. I.	6	172	4,300	.60
Plainfield, N. J.	6	261	10,000	.32
Springfield, Mass.	6	269	6,725	.48
Waltham, Mass.	6	82	5,685	.82
Worcester, Mass.	6	399	21,770	.50

*5 in. to 10 in. †5 in. to 8 in. **6 in. to 8 in. ††4 in. and 5 in.

Seasoning and Treating of Cross Ties.—The U. S. Forest Service has been conducting a series of experiments on the seasoning and preservative treatment of railway cross ties. Some of the conclusions reached as the result of these studies are as follows: The rate of seasoning, as affected by the position of the pile, depends largely upon local conditions. Hewed ties, which are peeled when cut, season much more rapidly during the first four months than unpeeled ties. At the end of a year's seasoning, however, the weights of both peeled and unpeeled ties are approximately uniform. The oven-dry weight of Douglas fir is 28.3 lbs. per cubic foot. The green weight varied from 41.7 lbs. in February to 37 lbs. in July. The minimum air-seasoned weight reached was 31.9 lbs. per cubic foot. Two distinct forms of checks occur on Douglas fir—radial and honeycomb. Timbers cut in June, July and August are particularly subject to radial checking. Honeycomb checks both follow the curves of the annual rings and are at right angles to them; they seldom extend more than 2 in. on the radius and form small, roughly rectangular figures when seen in cross section. Radial checks are by far the most destructive, and the practice of cutting tie and bridge timbers from Douglas fir and western hemlock during June, July, August and September should be discontinued. Furthermore, at all seasons dimension material over 6x6 in. should be partially air seasoned before being shipped east of the Cascade Mountains. Hewed ties peeled directly before treatment absorb more preservative than those peeled when cut, provided they have seasoned for an equal length of time.

Cost of Constructing Concrete Pipe.—The pumping plant for lifting water from the main canal of the Huntley Project of the U. S. Reclamation Service, near Ballantine, Mont., onto the high lands in that vicinity has been placed in operation. The pumping units and appurtenances were purchased by contract at \$12,675. The power house and all other concrete structures and their auxiliaries were built by force account at a total cost of \$38,753.75. The following data on the force account work are taken from the July Reclamation Record:

Distribution of cost.		Unit cost concrete 785.1 cu. yds.	Unit cost puddling 299 cu. yds.	Unit cost 49½" concrete pipe 1,607 lin. ft.	Unit cost 63½" concrete pipe 355.2 lin. ft.	Total cost from and wood work	Total cost miscellaneous	Totals
Labor	\$0.524	\$0.37	\$6.17	\$2.95	\$2.51	\$254.97	\$429.90	\$23,506.71
Materials	.....	.....	5.05	3.43	4.12	240.43	.....	12,133.99
Supplies	.....	0.012	.....	0.05	0.06	.....	240.69	695.03
Plant depreciation	0.027	.....	0.32	0.16	0.21	.....	45.58	1,289.94
Totals	\$0.563	\$0.37	\$11.64	\$6.59	\$6.90	\$495.51	\$716.26	\$37,625.66

In addition to the costs shown in the table are charges for engineering, amounting to \$1,073.67, and 9.63 cu. yds. of paving costing \$54.42, making the grand total cost of the force account work \$38,753.75. The charges for engineering cover a portion of the salary of the constructing engineer and the salary of an instrumentman and timekeeper and amounted to about 2.8 per cent of the total cost of the force account work. The records for concrete work other than that in pipes were kept together, as they were so closely related, and the item of concrete in the table covers 416.6 cu. yds. of plain and 368.5 cu. yds. of reinforced concrete. Under the item of miscellaneous charges have been placed such costs as relate to the work as a whole, and are, therefore, not readily distributive to the subdivisions of work. The reinforced concrete pipes are each 9 in. thick, and are reinforced with steel both longitudinally and transversely. The longitudinal reinforcement consists of twelve ¾-in. square bars, and the transverse reinforcement of sizes and spacings appropriate to the stresses due to the water pressure.

Treatment of Cuts on Horses.—On the farm the most common injury to horses is from barb wire. Injuries of this kind to horses in grading outfits are not so frequent, but the treatment of cuts resulting from other causes is practically the same as that from those sustained from barb wire. In all wounds it should be remembered that nature does the healing, and that remedies applied are simply for the purpose of assisting nature. In the case of a horse with a badly lacerated leg from contact with a barb wire, the first thing to do, of course, would be to stop the bleeding. This can be done by a tight bandage of clean

white muslin tied directly over the wound or above it. If the bleeding artery protrudes a thread can be run under it with a needle and the artery tied. Flour, dirt, cobwebs or anything of that sort should not be used on the wound, as they are unnecessary and may produce dangerous infection. The bleeding having been stopped, the clots of blood should be removed and the ragged edges of the muscles cut off with shears. A pan of antiseptic solution should be provided. One of the best and cheapest an-

tiseptics is creolin. Add a teaspoonful of this to a pint of boiled water, and place the knife, shears, etc., in the solution, and also wash the hands before beginning the operation. After having cleaned out the wound wash it thoroughly with the antiseptic solution. See that there is good drainage from the wound at the bottom. Do not allow it to start healing with a pocket that will hold puss. As it is practically impossible to keep a wound on a horse antiseptic, it is not advisable to tie up the wound; leave it exposed to the air and apply the antiseptic wash several times a day. Three good antiseptics are corrosive sublimate, which can be purchased at the drug stores in tablets all ready for use; formalin is good, as is also a solution of boracic acid. After about a week it is well to change to dry dressing; a powder composed of equal parts of boracic acid, charcoal and iodoform makes a very good dry dressing. Clean air-slaked lime, powdered over the wound twice daily, is very satisfactory. The so-called "proud flesh" is only unhealthy granulation.

It is seldom advisable to interfere with this condition by using caustics; the results are usually disastrous; better in this case to call in a qualified veterinarian. If maggots should get into the wound a little turpentine or chloroform will help bring them to the surface, where they may be picked out. In case of the ragged barb wire cut it is very seldom worth while to sew up the wound. A wound to heal properly must be gotten perfectly clean and free from germs from the start and then kept clean. Remember that it is largely a matter of keeping dangerous germs out and giving nature a chance. Too much interference is often the cause of tardy healing of wounds.

Cost of Transporting Men, Tools and Supplies on Railroads for Grading.

In carrying on construction work it is the custom of railroads to charge to construction certain rates of fares on the men employed, and freight on tools and supplies. This charge against the new work is credited to the operating department. Engineers in the employ of a railroad company in making up estimates for new work must include these charges, else the cost of the work is likely to overrun the estimate. To do this there must be some basis of the amount of work that a man, horse and machine will do in a given time, and an approximate tonnage of machines and supplies needed to excavate a given unit.

The same assumption applies to track work, bridges and buildings, but in this article we consider only the grading of a railroad.

The following figures have been used by one of the editors of this journal in estimating the cost of railroad construction. The figures of work done, and men, horses and tools and supplies needed are based on large jobs of construction, and are safe averages. The fares for men and the freight rates are those ordinarily charged by railroads for such movement of men and freight.

The costs follow:

One horse plus 1½ men readily excavate and move 15 cu. yds. of earth per day. Hence allow 360 cu. yds. per month per horse and 250 cu. yds. per month per man.

One man requires transportation at 1 ct. per mile, and freight on 200 lbs. of bedding, cooking utensils, tents, small tools, etc. Hence for 100 miles transportation each way, or 200 miles round trip, we have 200 passenger miles at 1 ct. \$2.00
1/10 ton bedding, etc., 200 miles at ½ ct. per ton mile. 10

Total \$2.10

Since one man will excavate 250 cu. yds. per month, it costs \$2.10 divided by 250, or 0.8 ct. per cu. yd., if the job lasts only one month; but if the job lasts four months it costs 0.8 ct. divided by four, or 0.2 ct. per cu. yd., because in that time a man will move four times 250 cu. yds., or 1,000 cu. yds., and will only require transportation once at a cost of \$2.10. Other months are in proportion. For any other haul than 100 miles multiply accordingly.

Each horse requires the following equipment:

½ wheel scraper, at 500 lbs.	250
½ wagon, at 2,000 lbs.	1,000
Tents, harness, etc.	250

Total 1,500

Allowing 16 horses per car of 24,000 lbs., each horse stands for freight equivalent to 1,500 lbs., hence:

Equipment for each horse.	1,500
Weight of horse.	1,500

Total, 1½ tons or. 3,000

For each 100 miles of haul we have, therefore, 200 miles round trip; hence 200 miles × 1½ tons × 0.4 ct. = \$1.20.

Since each horse moves 360 cu. yds. per month, we have \$1.20 ÷ 360, or 0.3 ct. per cu. yd., if the job lasts only one month. But if the job lasts four months we have ¼ of 0.3 ct., or 0.075 ct. per cu. yd. Other lengths of time and other hauls are in proportion.

Each horse consumes ½ ton of food per month; hence if food is hauled 100 miles we have ½ ton × 100 miles × 0.4 ct. = 20 cts.

Since the horse moves 360 cu. yds. per month, we have 20 cts. ÷ 360, or 0.05 cts. per cu. yd. for each 100 miles of haul.

Summing up, we have the following costs:

Duration of Work.	Cost per cu. yd. for transportation 100 miles and return.			
	Men.	Horses.	Food.	Total.
	Cts.	Cts.	Cts.	Cts.
1 mo.	0.80	0.30	0.05	1.15
4 mos.	0.20	0.08	0.05	0.33
6 mos.	0.13	0.05	0.05	0.23
8 mos.	0.10	0.04	0.05	0.19
12 mos.	0.07	0.03	0.05	0.15

Note.—If the haul is 300 miles, multiply by 3. If the haul is 500 miles, multiply by 5. If the haul is 1,000 miles, multiply by 10.

The above is for work done by wheel scrapers and wagons and carts, but for steam shovel work the following would be the approximate cost for transportation:

	Tons.
1 shovel.	70
60 dump cars.	120
Rail	65
Cross ties (6"x6"x6')	75
Three small locomotives.	35
Pumps, drills, etc.	35
Total	400

400 tons × 100 miles × 0.4 ct. = \$160.

Such a shovel as this will average at least 20,000 cu. yds. per month, hence we have \$160 ÷ 20,000, or 0.8 cts. per cu. yd. for transporting the shovel 100 miles. This is equivalent to 1.6 cts. for transporting the shovel the round trip of 200 miles, when the job lasts only one month. For four months the cost would be ¼ of 1.6 cts., or 0.4 ct. per cu. yd. Other months would be correspondingly in proportion.

Such a shovel does not consume more than 60 tons of fuel and supplies per month; hence we have 60 tons × 100 miles × 0.4 ct. = \$24. Since with this 60 tons of fuel there are 20,000 cu. yds. excavated, we have \$24 ÷ 20,000, or 0.12 ct. per cu. yd. With such a shovel there will never be more than 40 men engaged in operating the shovel, operating the dump cars and trains, as well as in making temporary roadways and repairing equipment; hence each of these 40 men averages 500 cu. yds. per month, which is double the output where men are working with wheel scrapers, carts, etc., as above given; therefore the cost of

transporting men per cu. yd. on shovel work is approximately one-half the amount given in the previous table.

Summarizing we have the following

Duration of Work.	Cost per cu. yd. for transportation 100 miles and return.			
	Shovel.	Men.	Fuel	Total
	Cts.	Cts.	Cts.	Cts.
1 mo.	1.60	0.40	0.12	2.12
4 mos.	0.40	0.10	0.12	0.62
6 mos.	0.26	0.07	0.12	0.45
12 mos.	0.13	0.03	0.12	0.28

The above is for a haul of 100 miles, and for any other hauls multiply according to the length of haul.

If the workmen are of a restless disposition, and remain only a month or two on the job before quitting, the cost of their transportation varies not with the length of the job but with the average time they remain on it. When they quit, of course their return fare is not paid.

Price of Rails for Thirty-Two Years.

Engineers in making appraisals of railroads, often have to consider prices of materials for the year in which the road was built. For reference purposes in such cases we publish below the price of steel rails at Pittsburg for the years 1876 to 1907 inclusive. We also include the price of iron rails from 1876 to 1882. After the last named date iron rails were seldom laid.

It will be noted that since 1888 the price of rails has never varied much from the present price, except in the years 1897 and 1898.

PRICE OF RAILS AT PITTSBURG, PA.
(Statistical abstracts of U. S. Dept. Commerce and Labor, 1905, page 539.)
(Ton equals 2,240 lbs.)

Year.	Price per Ton, Price per Ton.	
	Steel Rails.	Iron Rails.
1876.	\$59.25	\$41.25
1877.	45.58	35.25
1878.	42.21	33.75
1879.	48.21	41.25
1880.	67.52	49.25
1881.	61.08	47.13
1882.	48.50	45.50
1883.	37.50	
1884.	30.75	
1885.	28.52	
1886.	34.52	
1887.	37.08	
1888.	29.83	
1889.	29.25	
1890.	31.78	
1891.	29.92	
1892.	30.00	
1893.	28.12	
1894.	24.00	
1895.	24.33	
1896.	28.00	
1897.	18.75	
1898.	17.62	
1899.	28.12	
1900.	32.29	
1901.	27.33	
1902 to 1907.	28.00	

Methods and Cost of Constructing Telephone Booths, Buffalo, Lockport & Rochester Railway.*

The accompanying drawings show a standard construction for telephone booths along the Buffalo, Lockport & Rochester Ry. (electric) designed by the engineers of J. G. White & Co. of New York city. The

Some of the buildings have been made with the same design and dimensions, but with the exterior covered with Novelty sheathing instead of shingles. With this sheathing the boards overlap in such a manner that rain or moisture cannot get through, and it renders unnecessary the ordinary⁹ under sheathing. The cost of the

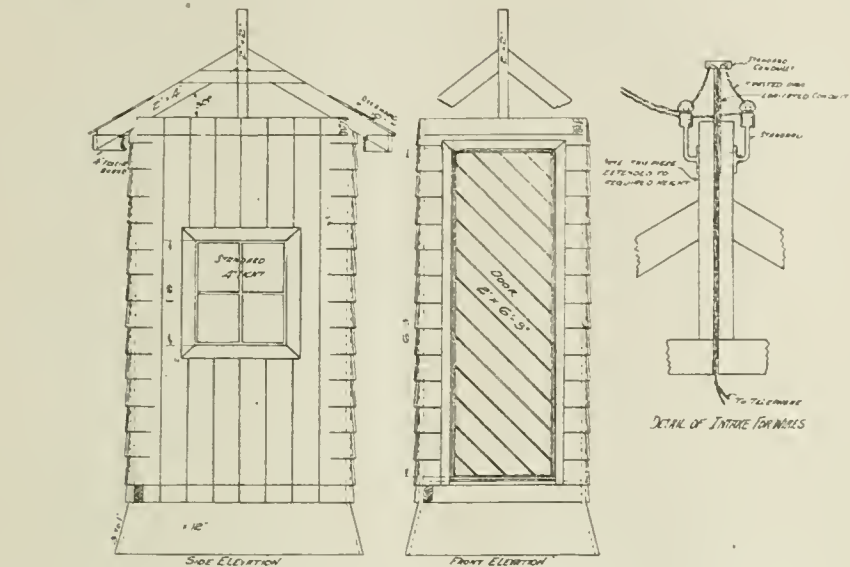
firmly as a single floor would be by the use of strips. Again the strips, if used, must necessarily reach down onto or into the coarse material, and they therefore have no protection against moisture from the ground reaching them, and there are many instances where they have been used and rotted, carrying rot to the floor itself. With the construction shown in the accompanying cut there is nothing beneath the inch of tar and sand that dampness can affect and no chance of dampness from the ground reaching the wood, and besides it will cost from 5 to 8 cts. per square foot less than the other method.

A Travelling Blacksmith Shop for Railroad Repairs, and Cost of Repairing Frogs.

On one of the divisions of the Missouri Pacific System there has been installed a portable maintenance of way blacksmith shop for the purpose of ascertaining how much convenience and saving of cost can be made by its use. The shop has two box cars fitted up for this work, one for the housing of the blacksmith and helper, the other for the shop in which is kept a forge, necessary tools, duplicate parts and all supplies necessary for repairing hand-cars, tools, frogs, switches etc.

The outfit is moved from place to place by the local freight train after its work is completed, the work requiring about one day's time at an ordinary section and a longer time when two sections are located at the same point or where there is a large yard.

In repairing frogs, where there is considerable traffic, duplicates of the stand-



Standard Construction for Telephone Booths, B. L. & R. Elec. Ry.

building measures 3x4 ft. x 6 ft. 3 ins. from floor to top of door. The sides and roof are shingled over sheathing. At the peak of the roof is an intake for the telephone wires. The details of this intake are shown. It consists of a 2x2-in. timber projecting 12 ins. above the roof, giving the telephone wires sufficient height to clear the trolley wires, center pole construction being used on this road. The supporting timber is drilled with a 3/4-in. hole and a conduit is inserted into the upper end. At the top of this conduit is a standard conduit. The telephone wires are anchored to insulators on standard side brackets lagged to the timber support. From these insulators wires pass to the conduit and down through the conduit. Wall 'phones are used and a shelf is provided for taking orders.

The cost of the little building is given as follows:

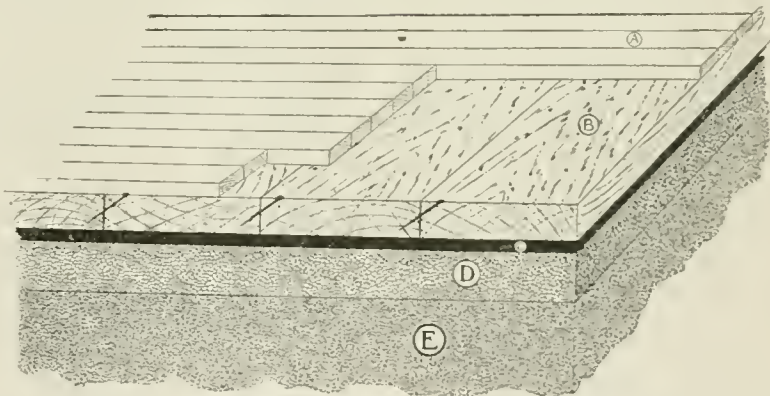
Material—	
Lumber	\$17.00
Nails, hardware, etc.....	3.00
Paint	1.00
	\$21.00
Labor—	
Erecting and shingling.....	\$ 7.00
Painting	2.00
Hauling	1.00
Foundation, grading and walk.....	5.00
Contingencies	4.00
	\$19.00
Total labor.....	\$19.00
Total material.....	\$21.00
	\$40.00

*Abstracted from "Electric Traction Weekly" for June 27, 1908.

building is slightly decreased with the Novelty sheathing.

Sleepers or Nailing Strips Unnecessary for "Tar-Rok" Floors.

With the article describing Tar-Rok Sub-Floors in our issue of June 17, the cut used was an old one and showed 2x3-in. nailing strips, which are entirely unnecessary. Where a double floor will be used the



Sketch Showing Construction of Tar-Rok Sub-Floors.
(A) Maple board, (B) Hemlock plank, (C) 1 in. tarred sand, (D) Tarred screened gravel, (E) Earth.

better method is to omit sleepers or nailing strips entirely, and bed the plank directly on to the top coat of tar and sand and simply toe-nail them together. By doing this the top coat of tar and sand may be only 1 in. thick instead of 2 ins., as shown in the cut, and this is a material saving. There is no more reason why there should be strips to nail planks to than why there should be strips to nail the strips to, and the hard wood floor will tie the plank together just as

ard frogs are put in place, while the one taken from the track is being repaired, but where the traffic is light or the repairs are not extensive, frogs are removed from the track, repaired and put in place again under the protection of flagmen. The proper adjustment of guard rails is looked after at the same time and the section tools are sharpened and repaired.

It has been found that the life of the frogs can be very much extended by the

repairs given on the ground. The cost for labor and material in repairing about 225 main track spring frogs has averaged about \$375 each. When the fact is taken into account that these frogs have not required any handling for shipment nor the use of cars in same, it is considered, as far as investigations have proceeded, that very satisfactory results have thus far been attained by this traveling blacksmith shop, in addition to the economies effected in repairing switches, tools, handcars and all other work of this kind pertaining to each section without the trouble and delay heretofore experienced in sending them to some other point of repairs. Likewise some articles are now repaired that would by the other method be thrown into the scrap heap.

We are indebted to Mr. M. S. Byers, chief engineer maintenance of way of the Missouri Pacific Ry. Co., for the information given.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0789. **Electric Arc Lights.**—Scott Electrical Co., 58 Nassau St., Newark, N. J.

A small 12-page pamphlet telling of the Scott flaming arc lamp. The lamp furnishes a powerful light for both out-of-door and inside use.

No. 0790. **Road Rollers.**—Buffalo Steam Roller Co., Buffalo, N. Y.

This is an attractive catalog of 33 pages, telling of the road work that can be done by this machine, and describing in great detail the construction and operation of the Buffalo Pitts Roller. Its ability to climb grades and go over obstacles is shown.

No. 0791. **Traction Engines and Road Cars.**—Buffalo Pitts Co., Buffalo, N. Y.

A 16-page pamphlet telling of the traction engines, road freight cars, and special stone spreading cars, manufactured by this company. Such equipment is especially designed for road building and heavy hauling over wagon roads. Every road engineer and contractor should have a copy of this catalog to acquaint himself with these machines.

No. 0792. **Damp Proofing Paint.**—Toch Bros., 320 Fifth Ave., New York.

A 135-page, cloth bound book, gotten up in an attractive and artistic manner and entitled the "R. I. W." Book. More than half the book consists of photographic reproductions of buildings and structures, upon which the damp proofing paints and steel protecting compounds, which this company manufacture, have been used. Besides the half-tones there are a number of pages telling of the R. I. W. damp resisting paint; "Tocholith" cement base paint for the protection of steel and iron, and "Toxment" and "Liquid Konkert" for water proofing and damp proofing concrete. This is a book that will be found useful to engineers, architects and contractors.

No. 0793. **Fireproofing and Concrete Construction.** The General Fireproofing Co., Youngstown, O.

A 12-page pamphlet called "The General." Tells of the cold twisted lug bar, the pin connected girder frame, expanded metal mesh, wire fabric reinforcement, "Herringbone" expanded steel lath, "Trussit" for roof slabs, and all steel doors, windows and office furniture and fixtures.

No. 0794. **Sand and Gravel Elevators.**—Shoemaker & Casparis, Newcomerstown, O.

This machine is used to excavate and load sand and gravel to be used either for concrete work, track ballasting, or other purposes. It is stated that it has dug and loaded, where its product was sold for 20 cts. per ton, with a profit that paid for the machine in six months. It loads either side of the bank, or screens and separates the sand and gravel.

No. 0795. **Road Rollers.**—The Kelly Springfield Road Roller Co., Springfield, O.

A catalog of 38 pages devoted to road rollers. More than 25 cuts of rollers are given. A feature of special interest illustrated, is that of the beveled driving wheels of large diameter, which allows the large wheels to conform to the finished surface of a highly crowned road, which means that the roadbed is not only compacted, but ironed to a smooth even surface.

No. 0796. **Rotary Pumps.**—P. H. & F. M. Roots Co., Connersville, Ind.

A 22-page pamphlet showing large rotary pumps for irrigation work, condensers, cooling towers, for circulating hot or cold water or brine, and for handling oil, tar or ammonia. The catalog also contains 7 pages of engineering data for selecting pumps.

No. 0797. **Dredges and Gold Dredging.**—New York Engineering Co., New York.

A 30-page catalog describing and illustrating the design of the ladder bucket dredge, manufactured by this company, and the various detail parts of the machine, with comments as to their manufacture and use. Shows sizes and capacities of machines made and discusses the use of dredging machines for gold mining.

No. 0798. **Ditching Machines.**—The Buckeye Traction Ditcher, Findlay, O.

This pamphlet of 32 pages is devoted entirely to the machines manufactured by this company for draining land, by excavating ditches, for either tile drains or open ditch work. The method of operating the machine is shown and data are given on the draining of land.

No. 0799. **Dredges.**—The Marion Steam Shovel Co., Marion, O.

A flexible leather bound book of 78 pages, showing half-tone pictures of a large number of dipper dredges sold by this company for harbor work, ditching for draining land, for canal work, phosphate digging and other work. Also dry land ditching dredges and for placer mining. Elevating bucket dredges for gold mining are likewise illustrated and commented upon.

No. 0800. **Steam Pumps.**—Warren Steam Pump Co., 95 Liberty St., New York.

In this 90-page catalog this company's pumps for various purposes are described and illustrated, and many tables of value regarding pumping and hydraulic work are given. A very useful catalog to be in the hands of any engineer or contractor.

No. 0801. **Pumps, Condensers, Etc.**—C. H. Wheeler Man. Co., Lehigh Ave. and 18th St., Philadelphia, Pa.

In this bulletin of 55 pages, drawings and photos are given of the pumps, condensers, heaters, cooling towers and other products.

No. 0802. **Placer Dredge Machinery.** The Bucyrus Co., South Milwaukee, Wis.

The dredge built by this company is of the elevating bucket type. In their 58-page cloth bound book on the subject, not only are illustrations shown of their machines, but much practical information is given as to placer gold mining on the dredges, which has been brought to a high state of development by the American manufacturers. The dredge is not only an excavating machine, but it also extracts the gold from the gravel, and deposits to the tailings in waste banks.

No. 0803. **Locomotive Cranes.**—Industrial Works, Bay City, Mich.

A beautifully printed catalog given over to illustrating by photographic reproductions the use of locomotive cranes for all purposes, as handling coal and other materials, for

wrecking purposes, erecting structural steel, digging earth, piling lumber, etc. The cranes are operated by steam or electricity, and have a capacity of 5 tons to 100 tons.

No. 0804. **Designing Methods Reinforced Concrete Construction.** Expanded Metal and Corrugated Bar Co., St. Louis, Mo.

The second of a series of bulletins treating of the designing of reinforced concrete structures. In this issue is discussed the design of a reinforced concrete building, including roof slabs, beams, girders, floor system, column design, footings, etc. The strength of rectangular beams and T beams is treated, and the location of the neutral axis discussed. These are valuable papers for the concrete engineer.

No. 0805. **Recording Instruments.**—The Bristol Co., Waterbury, Conn.

A small leaflet illustrating recording instruments for pressure, temperature, vacuum and electricity. This company states that they are now the largest manufacturers of this class of instruments.

No. 0806. **White Portland Cement.**—Vulcanite Portland Cement Co., Flatiron Bldg., New York.

For much work the color of the ordinary Portland cement is objectionable, hence there has arisen a demand for a white cement. The Berkshire "Snow White" is described in a 20-page pamphlet. It is used for Stucco work, tile floors, bath room walls, lining for refrigerators, station platforms in subways, setting white marble, statuary, and all decorative, ornamental and artistic finish of interior and exterior work.

No. 0807. **Improved Ventilators.**—Buffalo Forge Co., 41 Cortland St., New York.

A 16-page pamphlet illustrating and describing ventilators for use on buildings of all kinds, and also disk wheels for use in ventilating.

No. 0808. **Well drilling and Prospecting Machinery.**—Loomis Machine Co., Tiffin, O.

This catalog of 40 pages describes a horsepower drill that is unique in many ways. Although it is a hydraulic machine, yet owing to the special drill bit, and the operating of the lifting apparatus, a pump is not necessary. An ideal machine for light work, and for use by engineers for making wash borings.

Personals.

Mr. L. E. Stevens has been appointed City Engineer of Dowagiac, Mich.

Mr. Stephen G. Hobert has been appointed member of the Advisory Board of Consulting Engineers, Smoke Abatement Commission, of Chicago, Ill.

Col. William L. Marshall, at present in charge of the Engineer District of New York, has been appointed Chief of the Corps of Engineers, U. S. Army.

Mr. R. Budd has been appointed Chief Engineer of the Panama R. R. and the position of Engineer of Maintenance and Construction has been abolished.

Mr. James B. McCord, C. E., has removed his offices from 29 Broadway, New York City, to 42 Broadway, that city.

Mr. Henry T. Pierce has been placed in charge of the recently opened offices of the Chicago Concrete Machinery Co., at 911 Rothschild Bldg., Philadelphia, Pa.

The degree of Doctor of Science was conferred by Harvard University at its recent commencement upon Dr. William C. Gorgas, Chief Sanitary Officer Isthmian Canal Zone.

Mr. Alexander Leggat has resigned the position of City Engineer of Butte, Mont., and has resumed practice as a mining engineer, with offices at 35 Hibbour Bldg., Butte, Mont.

Mr. Bjorn J. Arnold, Chicago, Ill., has been engaged by the New York State Public Service Commission to supervise the appraisal of the properties of the traction companies in Manhattan and the Bronx, New York City.

Mr. G. B. Ashcroft, C. E., formerly Superintendent of the Roman Stone Co., of Toronto, Ont., has become Manager of the Cement Products Co., which has opened offices at 909 Balboa Bldg., San Francisco, Cal. The company will engage in the manufacture of "Roman Stone" (the Stevens process of liquid, sand casting, concrete) and other lines of cement work.

Mr. Thomas C. J. Bailey, Jr., has been transferred from the surface division of the District Engineer's office, Washington, D. C., where he held the position of Assistant Engineer, to the Sewer Department, where he will be the Assistant Engineer in charge. Mr. Bailey takes the position formerly held by Mr. Asa Phillips, who succeeded the former superintendent of the sewer department, Mr. D. J. McComb.

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for Civil Engineers and Contractors.

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The Problem of Waterproofing Concrete.

We give considerable space in this issue to a discussion by Mr. Sanford E. Thompson, M. Am. Soc. C. E., of experiments made by him to determine the possibilities in producing impervious or watertight concrete by the admixture of small percentages of hydrated lime to the cement. Broadly speaking the tests showed promising results. It is of the final paragraphs of the discussion, however, rather than of the test results that we wish to speak here. In these final paragraphs Mr. Thompson points out that securing watertight structures in concrete entails something more than adding a waterproofing compound. We have already spoken of this matter in our issue of Jan. 8, 1908, but it is important enough to bear repetition.

The study of waterproofing concrete has with a few important exceptions been limited to those interested in some particular waterproofing material or method. It has, therefore, been partial and to a great extent biased. This is natural and it does not signify that nothing good has been learned. The exact contrary is the fact: much valuable information has been secured and doubtless much of the information so secured that is of the greatest value has not been made public. The fault of this character of studies has been and is almost bound to be that their object is rather to learn how to waterproof a structure built than to learn how to build a waterproof structure. The distinction is sharp.

Mr. Thompson points out that however effective the addition of hydrated lime may be in producing imperviousness a waterproof concrete structure will not be obtained unless the material is perfectly mixed and placed and construction joints or shrinkage and other cracks are guarded against. In a word, waterproofness must be made an object of design and construction as well as of securing an impervious mixture and not merely the latter object alone. This is quite as true if instead of by impervious concrete the tightness against water is sought by introducing in or applying to the concrete structure a diaphragm or coating of some impervious material like asphalt.

The designer of watertight concrete structures like subways, basements, and underground galleries should evidently have in mind at least the four following things: First, the shaping and placing of the structure so as to turn away water; second, the planning of the structure from the first with provision for waterproofing as an essential structural feature. Third, the adaptation of the waterproofing to the probable lines of attack of the water, and fourth, ample provision for maintaining the integrity of the structure under all probable strains. All of these things are essential factors in the problem of waterproofing.

The protection of the structure from

the attack of water is one of the first items to be considered, and drainage is the main defense here. Waterproofing should not be called upon to make up the deficiency of poor drainage if the designer can avoid it, and it may be put down as a fact, we think, that a considerable proportion of our present waterproofing troubles could have been avoided had only a moderate amount of attention been given to drainage in designing the structure.

Designing the waterproofing as an essential fore-planned part of the structure should be a self-evident necessity, yet it is evidently in many cases only an afterthought of the designer. It is not at all uncommon to see waterproofing so detailed that it is almost a practical impossibility to carry it out in construction. The same carelessness is shown in proportioning the waterproofing to the stress of and the lines of attack of the water. Water is as much a positive force to be resisted in, say, a subway, as are the earth pressures and it varies as widely in intensity. The shell of the structure is invariably designed according to the supposed earth pressures and so should the waterproofing be designed according to the nature and intensity of the water pressures.

The final assertion that the integrity of the structure must be maintained is self-evident. As soon as the walls of a subway crack all waterproofing goes by the board. It is true, perhaps, that some of the diaphragm waterproofings in use are elastic enough to minimize to some extent the danger of cracking but this is a thin reed upon which to lean. A structure that must be watertight must be kept free from joints and cracks, and no means may be neglected which will aid towards this object.

To return again to Mr. Thompson's discussion, we consider its half-dozen closing paragraphs among the most important. They contain nothing that is novel or striking in character and they suggest rather than insist on certain things, but they embody a large truth. Waterproofing concrete is far more than a problem of developing an impervious mixture or of devising an impenetrable diaphragm or skin, it is a problem of design and construction to turn aside the attack of water.

A plant for making concrete blocks was installed at Ancon, Isthmian Canal Zone, in 1905, and has been maintained with a constant increase in effectiveness and decrease in the cost of its manufactured product. In the 11 months, ending May 31, according to the Canal Record, this plant made 17,969 blocks, at a cost of 12½ cents a cubic foot. They were used in building eight powder and detonator houses, three fire walls, one drive-way, and eight office vaults. The mixture is one part cement, three parts sand, and three parts stone chips. When three months old, blocks made of this mixture have shown a tensile strength of 342 pounds.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Tests to Determine the Effect of Addition of Hydrated Lime on the Water-tightness of Concrete.

These permeability tests were made to determine the effect of adding various percentages of hydrated lime to concrete of different proportions. The blocks of concrete were 20 ins. in diameter by 16 ins. thick, and the water was introduced into the center of the block.

The proportions of concrete selected were those which are customarily used in concrete construction, except that a slight excess of sand was taken in proportion to the stone to insure homogeneous specimens, thus avoiding the possibility of stone pockets, which are more liable to occur in small size specimens than in practical construction.

The materials, which are more fully described later in the paper, are quite representative, so that the results obtained are applicable to usual conditions in construction work. The cement was Lehigh brand; the crushed stone was conglomerate rock, which resembles trap in its characteristics and tests; the sand was a good, coarse bank sand. The hydrated lime was Pine Cone brand, made by the Rockland-Rockport Lime Co. of Rockland, Me.

The percentages of hydrated lime to add were selected after a careful study of the materials and the proportions, the plan being to use larger percentages of lime with the leaner mixtures because these contained more voids to be filled. The proportions of concrete and the percentages of lime selected by this preliminary study were as follows:

Proportions of concrete.	Hydrated lime.
1-2-4	0
1-2-4	4%
1-2-4	7%
1-2-4	10%
1-2½-4½	0
1-2½-4½	6%
1-2½-4½	10%
1-2½-4½	14%
1-3-5	0
1-3-5	8%
1-3-5	14%
1-3-5	20%

The tests were laid out by the writer at the request of the Rockland-Rockport Lime Co., and were made by the Boston Elevated Railway Co. in its Cambridge laboratory. The scheme of tests was approved by Mr. W. E. Healey of the Rockland-Rockport Co. and by Mr. George A. Kimball, chief engineer of the Boston Elevated Railway

Co., and the results are here presented with their permission.

Conclusions.—The following conclusions are drawn as the result of the experiments:

1. Hydrated lime increases the water-tightness of concrete.

2. Effective proportions of hydrated lime for water-tight concrete are as follows:

Port. cem.	Sand.	Stone.	Hyd. lime.
1 part	2 parts	4 parts	8%
1 part	3 parts	5 parts	16%
1 part	2½ parts	4½ parts	12%

These percentages are based on the weight of the dry hydrated lime to the weight of the dry Portland cement.

3. The cost of large water-proof concrete structures frequently may be reduced by employing leaner proportions with hydrated lime admixtures, and small structures, such as tanks, may be made more water tight.

4. Lime paste made from a given weight of hydrated lime occupied about 2¼ times the bulk of paste made from the same weight of Portland cement, and is therefore very efficient in void filling.

Although the character of the sand and stone used in the concrete will affect the best percentage of lime to use, the present materials are representative of average materials throughout the country, so that the results should be of general application. Coarser sand would naturally require slightly larger percentages of lime, and finer sand; that is, sands having a larger percentage of fine grains which pass a sieve with 40 meshes to the linear inch, would be apt to require less lime, since sands containing considerable fine material produce a more water-tight although a weaker concrete.

A study of the results suggests that for coarser sands than used in the experiments or in cases where the water pressure must be applied in one month or less after laying the percentages given above may be increased by about 25 per cent, while for many classes of work 25 per cent less than the above percentages will be satisfactory.

For mortar in proportion corresponding to the cement and sand in the different concretes the same percentage of hydrated lime would naturally be selected; thus 1-2 mortar corresponds to 1-2-4 concrete, 1-2½ mortar to 1-2½-4½ concrete, 1-3 mortar to 1-3-5 concrete.

Increasing the proportions of stone to, say 1-2-4½, 1-2½-5, or 1-3-5½, should have no effect on the percentage of hydrated lime to be selected, but for water-tight concrete it is always advisable to have a slight excess of mortar to avoid stone pockets.

Results of Experiments.—The water is introduced into the middle of the concrete cylinders. As it enters the specimen the pipe is enlarged so that an area of 12½ sq. ins.; that is, a circle 4 ins. in diameter is exposed to the water, and the water must flow through 8 ins. of concrete. The accompanying table gives the results of the tests in detail.

The percentages of hydrated lime are based on the weight of the cement, these being added to the cement and not replacing it. The variation in the ages of the specimens in different proportions slightly affects the results and accounts in part for the fact that the 1-3-5 mixtures are nearly as water tight as the richer proportions. Specimen No. 5, which shows practically no flow, is evidently erratic.

Permeability or Flow of Water Through Concrete 8 in. Thick.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Flow of water under 7-ft. head.			Flow under pressure of 60-lb. per sq. in.					
No.	Hydrated lime, per cent.	Age, days.	Duration of measured flow, hours.	Flow, grams per hour.	Age, days.	Pressure applied before measurement, hours.	Duration of measured flow, hours.	Flow, grams per hour.
1-2-4 Concrete.								
1	0	18	161	2.7	40	24	4¼	74.8
2	4	18	161	1.2	41	18	5	23.4
3	7	18	161	1.0	42	18	6¾	5.2
4	10	15	161	1.0	46	6	18	1.6
1-2½-4½ Concrete.								
5	0	30	169	0.3	44	17	6	1.1
6	5	30	169	1.9	45	18	6	32.5
7	10	29	169	0.8	49	..	21	0
8	14	29	169	0.7	50	..	27	0
1-3-5 Concrete.								
9	0	26	169	9.8	50	6	14	70.6
10	8	26	169	1.1	51	8	17	3.6
11	14	28	169	1.1	50	28	13	10.7
11	20	28	169	1.2	53	9	15	0.7

The specimens were first subjected to a head of 7 ft. by filling the vertical pipes with water, and while the results of these preliminary tests are of small value because the pressure in most cases was not enough to force the water through the specimen, the quantity being measured before entering the concrete, the results are given in the table, column 5, as confirming in a general way the tests of the concrete under city pressure. The tests under a 7-ft. head, column 4, were maintained for several days, and the flow was recorded each day, the average only being given in column 5.

After a longer period of setting, varying from 40 to 53 days, the specimens were connected with the city water pressure, which averaged 55 to 60 lbs. per sq. in. Before measuring the flow, the water was continued for several hours (column 7) to equalize the flow, and then the flow was measured for a period of several hours and recorded in grams per hour.

The flow given in grams per hour is very nearly the same as the flow expressed in ounces per 24 hours.

The result from one specimen, the 1-2½-4½ mix without any hydrated lime, is erratic, and this test is omitted in making up the curves. All of the tests show some variations in the lower portions of the curves, but when the flow through the specimen is as small as 10 grams per hour, which is ap-

*Abstract of a paper read before the American Society for Testing Materials, by Sanford E. Thompson, M. Am. Soc. C. E., Consulting Engineer, Newton Highlands, Mass.

proximately equal to about 8 ounces or $\frac{1}{2}$ pint per 24 hours, the concrete is so nearly water tight that slight variations are unavoidable. The pressure, nearly 60 lbs. per sq. in., which is equal to a head of about 140 ft., is unusual in engineering construction. Previous tests, by Fuller & Thompson, Trans. American Society of Civil Engineers, Vol LIX, p. 133, have shown that the flow through concrete is almost directly proportional to the pressure, so that for lower pressure the flow will be correspondingly less. The thickness of the concrete was only 8 ins. and water tightness increases greatly with the thickness.

In selecting the best percentages of hydrated lime for the different proportions of concrete, these points, as well as the fact that the 1-3-5 specimens are slightly older than the others, have been taken into account, and as a result of this study proportions suggested for general practice are 8 per cent for 1-2-4, 12 per cent for 1-2 $\frac{1}{2}$ -4 $\frac{1}{2}$, and 16 per cent for 1-3-5 concrete, these percentages of lime being based on the weight of the cement. As stated, smaller percentages than these—for example, 6 per cent for 1-2-4, 9 per cent for 1-2 $\frac{1}{2}$ -4 $\frac{1}{2}$, and 12 per cent for 1-3-5—give results which are satisfactory for many conditions in practice, while in certain cases a larger percentage may be chosen.

Frequently it is advisable to make special studies or tests with the materials available to determine the best percentage.

Previous Tests with Hydrated Lime.—A few permeability tests with hydrated lime admixtures made by the writer in 1903 indicated it to be a valuable material for water proofing. Later, in 1906, when the reservoir at Waltham, Mass., which is 100 ft. in diameter and 43 ft. high, was under consideration, the writer was consulted in the framing of the specifications and made another series of tests, using as follows:

Permeability Tests of 1-2-4 Concrete for Waltham, Mass., Reservoir, 1906.

Concrete 4 in. thick. Pressure 80 lbs. per sq. in.

Percentage of hydrated lime.	Flow in grams per min. at 14 days	(Max. flow.) per min. at 28 days
0 per cent.	5.52	2.92
2 per cent.	9.20	2.55
4 per cent.	2.82	1.49

Percentage of lime is in terms of weight of cement.

As a result of these tests 5 per cent of hydrated lime was adopted to mix with the 1-2-4 concrete in building its walls. The results were satisfactory, the only seepage occurring at joints formed between different day's work, where the bond between the old and new concrete was not made with sufficient care.

Construction of Water-Tight Concrete.—A paper on permeability is incomplete without reference to the general principles of construction which must be followed to produce a water-tight concrete. The concrete materials may be perfectly graded and the proper proportions of cement and of hydrated lime used, and then if the concrete is poorly mixed, mixed with insuffi-

cient water, or improperly placed, or if joints are left in the mass, the wall will invariably leak.

In the first place the mixture must be thorough, and in the second place sufficient water must be employed to give at least a "mushy" mix, so that it will settle into place with only a small amount of ramming.

Fully as important as the mixture is the bonding of the concrete between two days' work. For a small structure which must be water tight, it is advisable to place the concrete continuously, allowing no joint whatever, and not even permitting the concrete to stiffen up between the batches. Even an interruption of an hour in the middle of a hot day has been known to form a joint which will allow water to pass. If continuous work is impracticable, the old surface of the concrete must be thoroughly cleaned of all dirt and laitance or partially set cement, so as to expose the concrete. A layer of neat cement paste of soft consistency, or else of 1-2-1 mortar, should be then spread upon the old concrete after thoroughly wetting it, and the new concrete laid before this mortar has stiffened.

The placing of the mortar or paste, however, does not preclude the necessity of thoroughly cleaning the surface, for if any of the laitance or partially set cement is left on the old concrete, it will form a joint under the new mortar through which water will pass.

A long wall or a conduit may require longitudinal reinforcement to prevent temperature cracks and therefore leakage through them.

The board of directors of the American Railway Engineering and Maintenance of Way Association has appointed a special committee on wood preservation. A. L. Kuehn, Engineer of track and roadway, Cleveland, Cincinnati, Chicago & St. Louis Ry., is chairman and C. G. Crawford, specialist in wood preservation, U. S. Forest Service, is vice-chairman. The committee held its first meeting in Chicago early in June for the purpose of organizing and deciding upon a plan of work. The committee was divided into four sub-committees, as follows: Statistics and Economics, O. Chanute, Consulting Engineer, Chicago, Ill., chairman; Preservatives and Specifications, H. von Schrenk, Consulting Timber Engineer, St. Louis, Mo., chairman; Adaptability of Woods and their Preparation, W. K. Hatt, Civil Engineer, Forest Service, Lafayette, Ind., chairman; Treating Processes, C. G. Crawford, Specialist in Wood Preservation, Forest Service, Washington, D. C., chairman.

The city of Holyoke, Mass., is credited with having 4,827 dwelling houses of which only about 20 are unconnected with sewers.

LETTERS TO THE EDITORS.

Destruction of Portland Cement by Alkali.

Sirs: Referring to an article on the destruction of cement mortar and concrete by alkali salts at Great Falls, Montana, in your issue of June 21, I beg to state that some mistake must have been made. The description of the disintegrated sewer pipe reads like the description of concrete made with sand full of mica, or of concrete which had frozen while green. There is a large bar of apparently clean sand in the river near this place, which when used in making cement mortar will never set hard at all with any brand of cement. As to the effect of alkali salts on Portland cement concrete, there are numerous examples in this vicinity showing that there is no injurious effect. There is a natural depression in the northwest corner of this town which receives the seepage of several square miles of irrigated land. This seepage is a saturated solution of alkali. A 10-in. cement pipe was laid 25 years ago to drain away this alkali seepage. This cement pipe is still in service and in first class condition. There are many valve towers, wing walls, outlet pipes, etc., in this vicinity which stand in strong alkali water of irrigating reservoirs, and the concrete was mixed originally by the use of alkali water, and none of these concrete structures shows any effect of the alkali. There must be some other cause than alkali for the trouble at Great Falls.

M. E. SULLIVAN.

Longmont, Colo., July 11, 1908.

Irrigation works now contemplated by the Government of Formosa call for the expenditure of \$14,940,000. The work is to be started this year and will extend over a period of 18 years. In addition to twelve main canals, of an aggregate length of 295 miles, a dam of 90 ft. high and 1,800 ft. in length will be constructed on the upper Taikokan River, where it will be possible to store 7,000,000,000 cu. ft. of water, and near the mouth of the lower stream another dam will be constructed, from which will lead a canal 45 miles in length. A dam 90 ft. in height and 1,140 ft. in length will be constructed in the upper course of the Nisoko where 3,270,000,000 cu. ft. of water may be stored, and from which a canal 50 miles in length will lead. These two dams will provide sufficient water to irrigate 48,000 and 50,000 acres, respectively. The main canals will aggregate 390 miles in length, and the branch canals 1,560 miles. The total area to be irrigated will be 286,383 acres.

The Hedjaz Ry. in Arabia has been opened as far as Medina, and up to the present time has a total length of 932 miles, including the branch to Haifa. The work has so far involved the expenditure of \$15,400,000.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost of Excavating Sand in Trench With an Orange Peel Bucket.

In the construction of District Sewer No. 1 for the town of Gary, Ind., now being built by the Green & Sons Co., of Chicago, the preliminary excavation for the first 1,830 ft. was done with a Hayward orange peel bucket of $\frac{3}{4}$ cu. yd. capacity. The bucket was operated by a 25 H. P. hoisting engine and a separate swinging engine. The machine was mounted on rollers and moved forward with its own power by means of a "dead man" ahead.

The material removed consisted of fine sand of the kind prevalent throughout the Calumet region, the last 3 or 4 ft. of excavation being in water. The cut was in cross section as shown by the accompanying sketch.

The crew consisted of one engineer at \$6 per day, one foreman at \$3.50 per day and five laborers at \$1.50 per day who handled planks and rollers, built up runways for the machine in rough ground, and smoothed up the cut and left a smooth shelf for the

Some Cost Data on Irrigation Canal Excavation With Fresno Scrapers.

The following records of teams and men in canal excavation for the Belle Fourche Project, U. S. Reclamation Service, are taken from the "Reclamation Record" for July, 1908.

The work was done by contractors owning small outfits who hired their own men and were paid on the basis of the number of cubic yards of earth moved. The greater part of the work was done with Fresno scrapers and information relating to his portion is given in the accompanying table. The material consisted mainly of loam and sandy loam. In the first eight items of the

Item.	Overhaul cu. yds. per 100 ft.	
	Class A cu. yds.	B
1.....	11,009	1,890
2.....	14,839	390
3.....	5,576	.....
4.....	2,084	20
5.....	908	.....
6.....	7,819	6,060
7.....	6,350	1,700
8.....	15,685	3,310
9.....	14,900	5,900
10.....	5,834	2,840

An Air Jet Used to Load Wagons from a Hopper.

In excavating the foundations for the recently completed Hudson Terminal Buildings, the material was loaded into a bucket suspended from a carriage that ran on an I-beam. The bucket was run over a hopper, into which it discharged its load. Wagons were loaded from the hopper. The excavated material consisted of stiff wet clay and quicksand.

The water from the quicksand puddled the clay and compacted it so solidly that when the sliding door at the bottom of the hopper (see illustration) was opened to discharge the material into a waiting wagon below the hopper, the clay arched itself and it would not slip by gravity. This made it necessary to keep three to four men on a platform over the hopper to cut the material out by poking it with heavy slice bars. To load a 2-cu. yd. wagon in this manner, took about 10 minutes, there seldom being loaded in a day, from a hopper, more than 60 loads. Although

Total quantities balanced.		Cu. yds. per day		Cost per cu. yd.	
Wt. of A=1 man—day		Wt. of B=1½ day horse—day		cu. yds. per day	
C	D	E	F		
11,245	53.0	19.8	11.0		
14,948	42.6	17.0	12.6		
5,576	32.2	18.2	14.0		
2,086	25.4	12.1	20.2		
908	22.5	07.7	27.0		
8,576	42.4	18.4	12.3		
6,562	36.1	19.3	13.2		
16,099	38.4	19.3	12.8		
15,638	36.8	17.0	14.0		
6,190	31.9	20.8	14.3		

table the driver loaded and dumped the scraper; in the ninth, there was one man loading to each four or five scrapers, the driver doing the dumping; in the tenth, there were two men with each scraper loading following and dumping it. The cost includes superintendence and labor, but does not include plant depreciation or interest on investment. A charge of \$1.125 per day against each horse for subsistence, care and use has been made. The standard wages paid were \$90 to \$100 per month for foremen and generally \$2.50 per day of eight hours for laborers and teamsters.

The U. S. Civil Service Commission, Washington, D. C., will hold an examination on Aug. 19-20, at various cities throughout the country to secure eligibles from which to fill a vacancy in the position of chemist, Ordnance Department at Large, Picatinny Arsenal, Dover, N. J. The position carries a salary of \$2,400 per annum. Applicants must have had at least ten years' practical laboratory experience, at least three of which must have been in connection with the test and manufacture of smokeless powders and other explosives, and responsible for the chemical work of a smokeless powder factory.

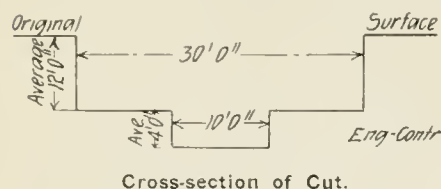
A meeting of the American Public Works Association will be held at Asheville, N. C., Sept. 29 and 30.

three hoppers were used, at times the material could not be hauled away as rapidly as it was excavated, thus causing it to be stored in the hoppers, making it still harder to discharge a load from the hopper.

It was accordingly decided to try an air jet to relieve these conditions. A pipe was run from the compressor plant, and a valve placed on it convenient to the platform on which the men worked. A hose was attached to the pipe and at the end of the hose a piece of 1 in. pipe 4 or 5 ft. long was fastened. This short piece of pipe was run down into the dirt and when a wagon was ready to be loaded the air was turned on. The air caused the earth to slide and the wagon was quickly loaded.

The number of teams were at once increased and in ten hours from 100 to 120 wagons were now loaded at a single hopper. The largest day's work was 143 wagons loaded in a day at each hopper, or 429 at the three hoppers. At times as high as 20 wagons were loaded in an hour, being at the rate of one every 3 minutes.

This trick reduced the cost of excavation materially, as the number of teams was doubled, and the excavation made each day was considerably increased, thus saving on the fixed charges. Then, too, only one man was needed at the hopper, thus saving the labor of nine men for the three hoppers. A 2-in. pipe ran from the compressor with air at 80 lbs.



Cross-section of Cut.

workmen following up the dipper. This makes a total labor cost of \$17 per nine-hour shift. The coal consumption averaged \$5 per day, making a total cost per shift of \$22.

The work was begun April 2 and the first 1,830 ft. were completed May 21, making 43 working days. The machine was shut down five days for repairs, and there was a night crew on for 13 additional shifts. This makes a total of 51 complete shifts. 51 shifts at \$22.....\$1,022.00
5 days' extra pay for engineer and fireman (during repairs)..... 47.50
Cost of oil and extra help on repairs, about..... 65.00

Total\$1,134.50

The total number of yards removed was 21,250, making a net cost of 5.3 cts. per cubic yard.

We are indebted for the above data to Mr. E. M. Schefflow, Assistant City Engineer, Gary, Ind.

The Government railways of Formosa will expend \$1,215,000 in the next two years on construction work.

Miscellaneous Cost Data on Irrigation Canal Work for the U. S. Reclamation Service.

Carefully compiled cost data are given in the "Reclamation Record" for July for the Lower Yellowstone Project on five con-

A Large Coal Grab Bucket.

The immense sizes to which manufacturers are prepared to build grab buckets was indicated in our issue of June 24 by the illustration of a 7½ cu. yd. clamshell having a 14-ft. spread of jaw. A still

more impressive example of magnitude is seen in the Brown patent coal grab bucket shown by the accompanying halftone view. This bucket has a capacity of 260 cu. ft. (9.63 cu. yds.), or approximately six tons of coal.

The spread from point to point of spades is 17 ft. 6 ins. and the width of spade 7 ft. 8 ins., covering an area of 135 sq. ft. when open. The total weight is roughly 15,800 lbs., and the total height when open is 13 ft. 9 ins.

The shell is made of flanged steel plates and stiffened on the inside with two 85-lb. T-rails, which form guides for the cross-head.

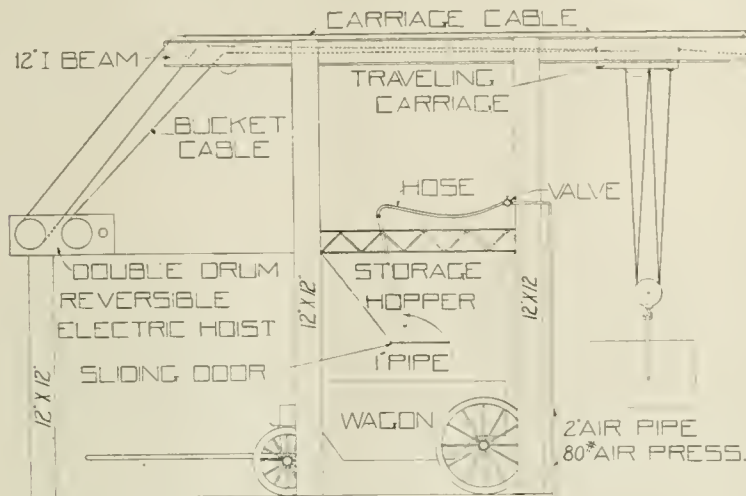
The sheaves that are used in operating the bucket and the sliding trunion blocks are bronze bushed and are equipped with grease cups for lubricating. The ropes are guarded at the openings in the top block with bronze castings, which can be renewed without delay.

This bucket is part of the coal handling plant built for the Astoria Light, Heat & Power Co., Astoria, N. Y., and is guaranteed to handle 200 tons per hour, out of boats onto docks, a distance of 360 ft.

We are indebted to the builders, the Brown Hoisting Machinery Co., Cleveland, O., for the information given above.

Gov. Magoon on June 22 signed a decree authorizing McGivney & Rokeby to carry out their contract for the construction of a sewer and water system in Havana, Cuba, and the paving of the city. This work will cost about \$11,000,000, one-third of which is to be paid by the city and the remainder by the Cuban government.

The maximum draft of vessels navigating the Suez Canal having been increased since January 1, the regulation then in force has been modified as follows: The passage through the canal is open to all vessels of whatever nationality, on condition that their draft of water does not exceed 8.53 meters. The maximum draft is thus increased 1 English foot, or from 27 to 28 ft.



Arrangement for Loading Wagons with Aid of Air Jet.

COST DATA ON LOWER YELLOWSTONE IRRIGATION PROJECT.

Item.	Contr. No.	Total quantity, cu. yds.	Price bid.	Unit cost to contractor.	U. S.
Excavation, Class 1 ¹	82	44,399	\$0.15	\$0.173	\$0.176
Excavation, Class 1.....	167	45,116	0.25	0.183	0.267
Excavation, Class 1.....	167	46,796	.30	.178	.317
Excavation, Class 1 ²	198	20,599	.23	.095	.231
Excavation, Class 1.....	198	3,642	.25	.101	.253
Excavation, Class 1.....	49	25,829	.25	.337	.297
Earth embankment (canal).....	211	4,469	.33	.187	.34
Earth embankment (dam).....	211	4,950	.33	.20	.34
Excavation, Class 3.....	49	65	.50	1.72	.76
Overhaul.....	211	3,086	.03	.017	.031
Rockfill.....	211	33	3.00	1.81	3.09
Backfilling.....	49	5,319	.55	.256	.58
Concrete, Class 1.....	49	2,407	6.25	7.80	10.65
Concrete, Class 2.....	49	136	5.75	7.05	9.87
Placing reinforcing steel.....	49	187,929*	.01	.607	.603
Structural steel in place.....	49	14,146	.08	.094	.093
Cast-iron in place.....	49	1,642*	.07	.102	.084
Lumber in place.....	49	4,860†	45.00	\$2.25	54.41
Riprap.....	49	1,056	2.00	2.58	2.36

¹ Includes overhaul 1,455 cu. yds. 100 ft. for which \$29.10 was paid but no separate record kept of contractor's expense therefor.

² 129 cu. yds. wet excavation included for which \$1.00 per cu. yd. was paid, but no separate record of cost to contractor kept.

* Includes cost of steel also.

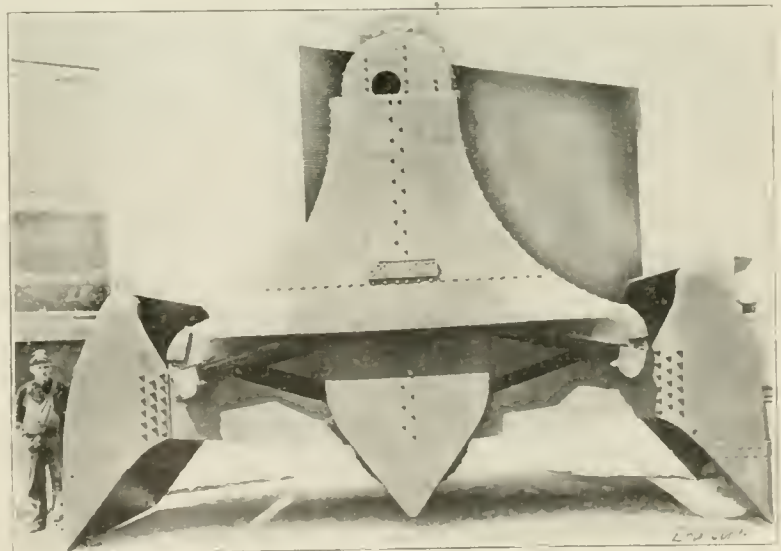
*Pounds.

†Feet B. M.

tracts covering a variety of canal work. The accompanying table is a summation of these data showing the kinds of work involved, together with the unit costs thereof both to the contractor and to the United States.

The unit cost to the contractors in every case includes all interest on investment, preparatory expenses, plant depreciation, labor, materials and supplies chargeable to the work. For contracts 82, 167 and 198 charges for executive are also given. The unit cost to the United States includes the unit bid of the contractor and charges for engineering and cement and reinforcing steel for concrete.

The work under contract 49 was done during 1905, 1906 and 1907, that under 82 during 1906 and 1907, that under 167, 198 and 211, during 1907. The wages paid per man per day of nine and ten hours were either \$2.50 or \$2.75, and those paid for team, including driver, were either \$5 or \$5.50.



View of Brown Coal Grab Bucket.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Planning the Execution of a Contract for a Dam, the Methods Used Together with Some Notes and Comments on the Plant Needed and the Life of Such a Plant.

In 1905 the Aqueduct Commission of the City of New York received bids for the construction of the Cross River Dam, in the Croton watershed. The reservoir has a water surface area of 981 acres and a capacity of 11,845,000,000 gals. The construction of the dam was recommended in January, 1905, by the Commission on Additional Water Supply, as being needed as a reinforcement of the Croton supply. For this reason the building of the reservoir was looked upon as emergency work, and it was the desire of the commission to have it done in the shortest possible time.

Incidentally it may be remarked that during every decade since 1829, when there was felt a need for a better water supply, there have been agitation, legislation, investigation and recommendation for increasing the water supply of New York, and with the wonderful rapid growth of the city, the additions built to the water supplies have to a great extent been looked upon as emergency work, as for nearly a hundred years the city has outgrown the "planned supply" before it was completed. This has been the excuse for many extravagancies on the part of the city, and the public have become reconciled to it by the bugaboo of a "water famine," which is always a possibility.

The commission, being duly impressed with the importance and urgency of the Cross River work, decided to submit to each of the seven bidders on the dam a number of questions to be answered by the contractors, in order to post the commissioners as to the ability of each contractor, and to learn the resources in the way of plant and capital that they could bring into play in executing the work. Answers to these questions brought to light much valuable information that has never appeared in the engineering journals. In this article we have extracted the greater part that may be found useful to engineers and contractors.

The dam is located on Cross River, an affluent of the Croton River, about a mile east of the village of Katonah, Westchester Co., N. Y. The nearest railroad station was Katonah, on the Harlem Division of the N. Y. C. and H. R. R. R. The dam is situated between two hills, the river bottom having an elevation at this point of 220 ft. above tide water, the elevation of the top of the hills being over 350. The

elevation of the top of the dam is 340 while the elevation of the spillway is 230. The dam, built of cyclopean masonry and faced with large concrete blocks, has a length of 840 and a maximum height of 170 ft., the foundation having elevation 170.

The cross section of the dam at the base shows an extreme width of about 115 ft. At elevation 230 the width is about 70 ft., tapering at the top to a width of about 23 ft. A wagon road crosses on top of the dam. At the southerly end the dam terminates with an abutment from which a masonry core wall is built into the hill side. A circular structure called the bastian is built at the north end of the dam, and from the bastian a water weir about 240 ft. long is built along the hill side, while a waste channel cut in the rock extends around the waste weir and around the main dam to the river channel below the dam. Two 48-in. outlet pipes are built into the lower part of the dam, north of the river channel. They are provided with valves and other devices for controlling the flow of the water, which are placed in suitable chambers. From the down stream gate chamber a reinforced concrete conduit was constructed to a circular fountain basin, from which the water is to overflow into the river channel. In connection with the reservoir there were built about 5 miles of highway, about 47,000 lin. ft. of wooden fences and guard rail and about 90,000 lin. ft. of boundary wall.

The principal quantities of work done were:

About 225,000 cu. yds. of earth excavation and refilling, and 60,000 cu. yds. of rock excavation, 1,500,000 ft. B. M. of timber and lumber and 5,000 lin. ft. of round piles; 135,000 lbs. of Portland cement 17,500 cu. yds. of concrete blocks; 6,000 cu. yds. monolithic concrete; 132,000 cu. yds. of cyclopean masonry; 4,000 cu. yds. dry rubble paving; grading, face dressing and other work in connection with the masonry. There were 156 tons of steel and iron pipes, special castings, miscellaneous brass and bronze castings, wrought iron, etc., besides the valves and sluice gates. There was also 870 acres of land to clear and 34,000 sq. yds. of embankment surface, upon which grass was planted. The engineering department had worked out a plan for building the masonry by means of derricks mounted on steeltowers, as had been done at the new Croton dam. For this purpose the contractor was to furnish 160 tons of steel.

One contracting firm, the Ryan-Parker Con. Co., of New York, in answer to the question, "What scheme have you worked

out for doing the work at the Cross River dam, so as to complete the various parts and the whole work in accordance with the schedule" wrote as follows:

"We would install a railroad from the bottom of the valley to the level of El. 340 on the south side of valley at site of dam to bring in coal, cement and supplies, and would establish quarry plant at elevation 340 to get out stone for concrete and rubble on that side of valley, putting in two complete crushing plants, in duplicate installation, with two cubical mixers, discharging concrete at elevation 290, at which elevation we would construct a 3-track trestle across the valley above the dam. Above this trestle we would install traveling stiff legged derricks, seven or eight in number, with 75-ft. booms, capacity 10 tons, equipped with swinging devices for rapid work, and in addition the trestle will be equipped with chutes for delivering the concrete at the level of the masonry. The boiler plant would be installed on the south side of valley, west of dam, at elevation 322.5. We would equip the work with about four stiff legged derricks, on down stream side of dam, to build the toe work. A concrete block plant and yard would be established at elevation 290, on south side of valley, equipped with an independent mixer, and traveling crane of five tons' capacity, with block room sufficient for 1,500 blocks and capacity for 72 blocks per day. We would also install two 950-ft. span cableways for preliminary work in excavation and bottom work.

"Sand and gravel would be obtained at station 4 to 11 and 21 to 28 on the railroad from the valley.

"At the earliest possible date, not later than July 20, the making of concrete blocks would be begun and 750 would be made at the outset, sufficient to bring the masonry up to elevation 220. October 20 these would be old enough to use, at which date the bottom of the dam under the 5-ft. pipes of the sluiceway would be in place and the sluiceway in operation, leaving the channel ready for attack.

"By this time the trestle would be built and the derricks put on it and at work from end to end of dam, and by January 1 the masonry would be up to elevation 230. During January and February quarrying would go on and 20,000 cu. yds. of stone would be gotten out and stacked on the base of the dam. March 15 we would have on hand 1,500 blocks, 20,000 cu. yds. of rubblestone and 10,000 cu. yds. of broken stone for concrete ready for the spring campaign.

"We would stock up the cement houses with not less than 20,000 bbls. of cement during the winter, and by April 1 we would be in a position to place 1,000 cu. yds. of masonry each day. All work below elevation 315 would be placed by gravity and with eight derricks at work this would not be difficult to accomplish. Our mixers would have a capacity of 800 cu. yds.

of concrete daily. We have made and placed concrete at the rate of 550 cu. yds. in ten hours with our mixer and have repeatedly exceeded 400 cu. yds. in 10 hours, so we have no anxiety as to that part of the work.

"We would have our shanties in order and 250 men on the ground in three weeks. We would have a sawmill at work in three weeks getting out lumber and would have our railroad in operation in one month from the day we began work, and our plant would be completely installed in sixty days.

"We would have a complete modern

cuted, as the contract was awarded to MacArthur Bros. Co. and Winston & Co., who substituted the following plan for doing the work. We quote from their letter:

"To fully comply with the terms and specifications and especially to complete the work within the time prescribed (on December 15, 1906), the scheme we propose to use for executing this work and the plant to be installed is as follows:

"One 1,000 H. P. central air compressor plant. Three 10-ton cableways spanning the valley above the coping, two of them traveling cableways so as to be available

capacity cubical batch concrete mixers, of most approved type. One of these mixers to be immediately set up and devoted constantly and exclusively to the manufacture of concrete blocks, which we believe an important item in the progress.

"Two stone crushers having 700 cu. yds. capacity for concrete, and one stone crusher of 100 cu. yds. capacity to be used exclusively for the manufacture of concrete blocks.

"The building of ample standard gauge tracks between the quarry and the mixers and the dam, the whole connected by a proper system of frogs and switches to



Fig. 1—View of Construction of Cross River Dam for the Aqueduct Commission of New York City.

plant of about 30 double drum hoisting engines, 10-ton derricks and miscellaneous plant now at work and being released daily. We have two 5-ft. cubical mixers ready to install at once and a great variety of pumps, boilers, etc., for independent installation as needed. This plant is all comparatively new, most of it having been in use less than three years. We have the advantage of all the working drawings of plant used on five jobs in the past seven years, aggregating two and a half millions of dollars, and can duplicate our equipment throughout in 30 days."

This proposed scheme was never exe-

at any point of the work. Two 5-ton cableways working at right angles to the axis of the dam for excavating purposes solely.

"One large pumping plant sufficient to pump the water to be handled in excavations and foundations, with an auxiliary plant of equal size alongside for any emergency.

"For drilling foundation and the cut-off particularly, 50 air drills, so this work may be kept far in advance of the masonry.

"The use of some forty derricks of modern revolving type, fitted with the latest engines and having a capacity of six cu. yds. The employment of three 3-cu. yd.

deliver the materials of construction. Three locomotives for prompt service in handling materials to the various parts of the work. Thirty 60,000 lbs. capacity standard gage flat cars for handling stone and materials. A full complement of 4 cu. yds. cableway skiffs and buckets for handling stone and concrete and the various materials of construction.

"The installation of two complete piping systems—one for the distribution of compressed air power and the other for the distribution of water wherever required upon the work. We also propose to install for this water system at a high eleva-

tion a large water storage tank or reservoir, so as to furnish a constant and ample supply of water under high pressure for general purposes and particularly for cleaning and scouring foundation and beds and the stone and materials of construction.

A large machine, repair and blacksmith shop, equipped with steam hammer, lathes, pipe cutters, saws, forges, pneumatic tubes and all appliances necessary for keeping all plant in repair and meeting emergencies.

"All necessary buildings for housing and caring for men, live stock, etc., including the necessary sanitary arrangements according to requirements.

"We have on hand now all the plant above enumerated, the value of which is approximately \$300,000."

Regarding the plan worked out by the engineering department of the Aqueduct Commission, for the execution of the work, these contractors had the following to say:

"We have carefully examined the plan and scheme of doing the work as proposed by the chief engineer and are satisfied of its many advantageous features. We have proposed the alternative plan of plant installation, however, because we feel from our own recent experiences that with such a plant as we are able to immediately install we can accomplish in the way of progress all that can be accomplished by the other plan, and much more.

"It will be noted, moreover, that the plan and the plant we propose to use is built in a system of units and auxiliaries capable of multiplication as the needs of the work may demand, or emergency may require.

"Furthermore, we desire to point out that our position in regard to our plant and methods proposed enables us to so advance the work that the storage of water in the reservoir can go on simultaneously as the wall increases in height, as there will be no plant or paraphernalia or operations in the basin other than the subsidiary work of clearing, road changing, etc., within the area of the reservoir, all of which subsidiary work in and about the basin can be easily cared for and completed well in advance, as required."

The contract for the work was awarded on June 20, 1905, at their bid of \$1,246,211.60. The work was commenced at once, but was stopped from Sept. 15 to Nov. 14, 1905, on account of an injunction obtained against the Aqueduct Commissioners in connection with a taxpayers' suit. The injunction was dissolved on Nov. 14, and work was immediately resumed.

On May 25, 1906, the first stone was laid in the dam. By Jan. 1, 1907, the following work had been accomplished. All the excavation for the foundation of the dam had been completed except at the ends of the dam. Good progress had been made in the excavation for the waste weir and channel. The top of the dam was at an average elevation of 266 above datum, which was 59 ft. above the river bed and 74 ft. below the

elevation of the top of the dam. In all 87,810 cu. yds. of masonry of the various kinds were laid, the maximum quantity being laid in any one month being 18,130 cu. yds., this being done in October, 1906.

The entire masonry was built in about ten working months. Six gangs were worked on the dam, each gang composed of two masons, six laborers and a derrick engineer. During the month of October, 1906, each of these gangs laid an average 108 cu. yds. per day. This was exclusive of eight masons laying concrete block face masonry. These eight masons laid 1,600 cu. yds. of blocks in that month. In 5½ months of 1906 these six gangs laid 81,000 cu. yds. of masonry. The best monthly records during 1907 were April, 15,660 cu. yds.; May, 16,830 cu. yds., and June, 14,200 cu. yds. When the masonry became narrow, landing platforms, as shown in Fig. 1, were used to receive the materials, to be afterwards handled by the derricks.

This brings into comparison the three proposed methods of building the dam. First that of steel towers, as proposed by the engineering department; second, that of Ryan-Parker Con. Co., of building a 3-track trestle on the up-stream side of the dam, and third, the use of cableways.

It is evident that with the towers, the 160 tons of steel is an entire loss, while the material used in the trestles and cableways can be used in another job. Then with the towers, a railroad or cableway must serve the derricks or else the material must be handled from one end of the dam to the place of deposit by a succession of derricks, which is slow. With a track on the dam the service will be slow, and the grade of the track will have to be repeatedly changed. With a trestle these difficulties are all overcome, but the reservoir cannot be filled up and used as the masonry is built, as the plant for constructing it prevents this. With the Lidgerwood cableways this is not so, and by their use the various tools and machines, such as hoists and derricks, can be quickly and economically moved on the dam. If the cableways are traveling ones, they reduce the cost of the plant and serve materials over a greater area.

Fig. 2 shows a view of the concrete block casting and storage yard. Blocks weighing as much as six tons were used. The method of making them was designed and patented by Mr. J. O. Winston. The concrete was dumped by derricks onto a traveling platform 12x20 ft. and 6 ft. above the ground, running on four rails. The moulds were placed between the rails under the platform, or to one side of the platform, and as it moved along, several forms were filled in unison. Six men were used on the platform, and three men on the moulds. The concrete was mixed by a 1 ft. cube mixer, which emptied the concrete into dump buckets. The forms were removed from the blocks after 30 hours, and after ten days the blocks were piled up in the storage yard, where they were

seasoned for three months, after which they were placed in the dam.

The entire job was completed in the fall of 1907, being nearly a year behind the original contract time, but the two months' delay in the fall of 1905 meant great delay in preparing for the work, and the job was carried through two winter seasons. This plant, valued at \$300,000, was thus used nearly 2½ years on this job. It had been used previously on the Wachusett Dam, near Clinton, Mass., with the exception of the two small Lidgerwood cableways, which had previously been used on some railroad work, first in carrying spoil from a tunnel across a river and afterwards in building bridge piers in the river. These cableways had a span of from 900 to 950 ft., with "A" frame towers 70 ft. high, having a capacity of 3 tons. The engines had 9x10 in. cylinders and double 41-in. drums. The large cableways had spans of about 1,250 ft., with aerial dump for excavation work, with 93-ft. head towers and 63-ft. tail towers. The capacity of these cables was 10 tons. The main cables were 2¼ ins. in diameter, while the engines were 10x12 ins. with 51-in. double drums, all 5 cableways were manufactured by the Lidgerwood Manufacturing Co., of New York.

The contract for the building of the Wachusett Dam was let to MacArthur Bros. Co. in October, 1900. The estimated cost of work to be done was \$1,603,635. The principal items of work done were about 270,000 cu. yds. of earth, about 100,000 cu. yds. of rock excavation, and about 350,000 cu. yds. of masonry of all classes. This masonry work was rubble, for the interior of the dam, and ashlar for the exterior, a granite being used. In addition to these items there were some brick masonry, some pipe culverts and drains, iron and metal work and other details that go with dam construction. This job was completed in the latter part of 1905, thus taking five years to complete the dam, and giving an annual output of masonry laid by the plant during the life of the contract of about 70,000 cu. yds. The dam was 971 ft. long, with a maximum height of 228 ft. The width across the bottom of the dam was 175, while at the coping it was about 25 ft. In addition there was a spillway 452 ft. long.

Two of the cableways used at Cross River Dam were used on this job, the span being 1,253 ft. The stone dressing plant used on this job was not needed at Cross River. The distinguishing feature of this plant is the central compressed air power plant. This plant generates 1,000 H. P., and at the Wachusett Dam this power was conveyed to some 80 different engines.

At the Wachusett Dam the power house was located between the dam and the quarry, being a half mile from the latter and 1¼ miles from the dam. Two Rand-Corliss compressors, now manufactured by the Ingersoll-Rand Co., of 500 H. P. each, made up the plant. The engines were de-

signed to operate under a steam pressure of 135 lbs., with cylinders of 18 and 34 ins. diameter for the high and low pressure respectively, with a 42-in. stroke. The cylinders of the air compressors are 21 and 34 ins. diameter for the high and low pressure, respectively. At the normal speed of 75 r. p. m., each compressor delivers 3,310 cu. ft. per min. of free air raised to a pressure of 90 lbs. per sq. in. The high and low pressure cylinders can be run separately. The air was delivered on the work through an 8-in. pipe, 6,500 ft. long.

At one time the following tools and machines were being operated by this plant: 31 hoisting engines of about 16 H. P. each, 2 cableway engines of about 50 H. P. each, 3 pumps of 3 to 4-in. discharge, 16 No. 3

used about 5 years at Wachusett, when it was moved to Cross River, where it was worked 2 years. A machine shop, equipped with a trip hammer, lathes, etc., being part of the plant, allowed of instant repairs being made when needed, and when the plant was moved it was no doubt overhauled and many new parts added. Thus this plant, after being in use for 7 years and having built about 500,000 cu. yds of masonry, was moved during the winter of 1907-8 from Cross River to the Ashokan Dam, the owners of the plant having been the successful bidders for that work. In this moving it was no doubt given another overhauling. There has been added to the plant four 1,530-ft. span traveling cableways, manufactured by the Lidgerwood Manufacturing Co. The capacity of these new cableways is 15 tons. There are about

the following for monthly depreciation on plant:

Locomotives,	1.1%.
Cars,	1.1%.
Track,	1.1%.
Excavators,	1.1%.
Machinery,	1.1%.
Scrapers, wagons, etc.,	2.0%.
Small tools,	5.0
Horses, mules, etc.,	2.0%.
Camp equipment,	2.0%.
Boats, scows, etc.,	4.0%.
Office furniture, etc.,	1.1%.
Real estate,	0.5%.

(See Engineering Contracting, Feb., 1906.)

These percentages of depreciation are no doubt based on the long experience of this firm, which has been in the contracting business more than 75 years, and they can

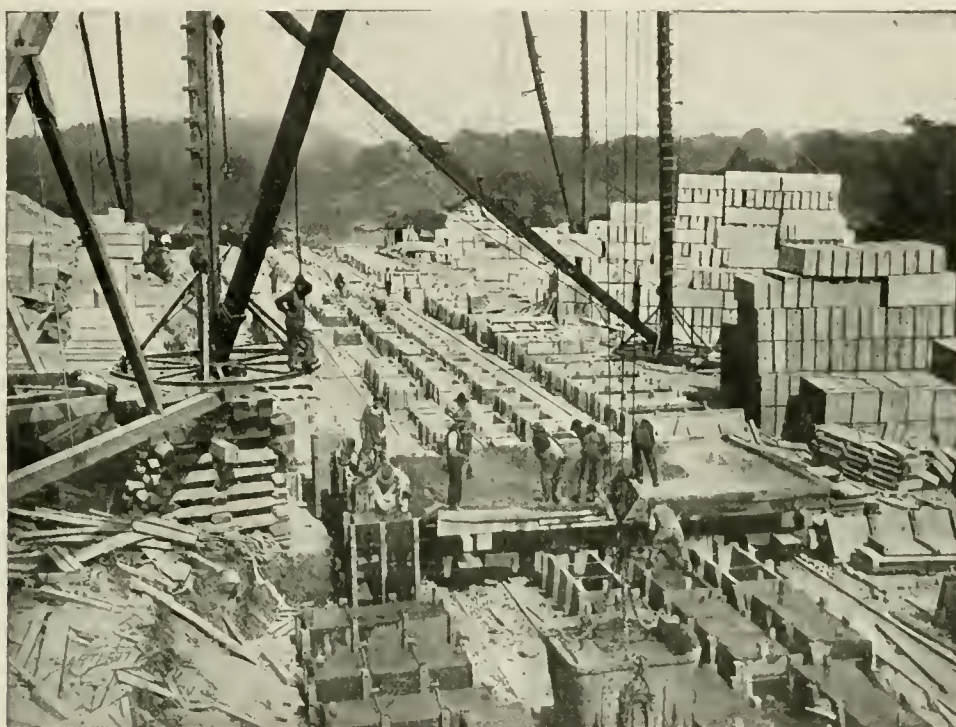


Fig. 2—View of Concrete Block Casting and Storage Yard at Cross River Dam.

Ingersoll-Rand drills, 1 engine or revolving screen, 1 engine in machine shop, 1 engine on mortar mixer, 1 pneumatic riveter, 10 Kotten plug drills, 3 stone dressing machines, 1 trip hammer and 10 blacksmith forges. At one time 40 rock drills were worked. While most of these machines were grouped at two places, yet there were some scattered machines, one derrick being as much as 3 miles away from the power house, the loss of air in conveying it this distance being but slight.

The reader who is interested in central power plant construction work versus independent units, and steam plants versus air, is referred to "Rock Excavation—Methods and Cost," by H. P. Gillette, Chapter IV., pp. 47-71.

This plant for constructing masonry was

750,000 cu. yds. of masonry of all kinds to be built at Ashokan, the main dam being of cyclopean masonry faced with concrete blocks similar to the Cross River Dam. For details of the work to be done at the Ashokan Dam, see Engineering-Contracting, Feb. 12 and 19, 1908. It is estimated that 7 years will be consumed in constructing this dam, hence the plant installed will be expected to last that long.

We then find that a plant of heavy masonry construction that has already been in use 7 years is installed on a job to do work for 7 additional years. The possession of this plant by these contractors has been a decided aid to them in securing both the contract for the Cross River Dam and the Ashokan Dam.

What is the depreciation of such a plant? The firm of MacArthur Bros. Co. allow

be applied to this outfit. Taking the value that they have placed on this plant, namely, \$300,000, the monthly charges for depreciation for 84 months, or 7 years, will amount to about the original cost of the plant.

The largest piece of masonry construction in a dam in the United States that has ever been built was the new Croton Dam, located in Westchester County, New York. The dam proper was 1,168 ft., with a spillway on one side of 1,000 ft. long. The lowest part of the foundation was 123 ft. below the bed of the river, while the top of the dam was 173 ft. above the river bed, making a total height of 296 ft. The base was 206 ft. wide, while the top was 19½ ft. The total amount of masonry built was about 900,000 cu. yds. The contract for this work was made in August, 1892. Various changes were made

in the work and the dam was not completed until January, 1906. Mr. J. S. Coleman and his associates were the contractors on the work throughout.

The general method of doing the work was as follows: The excavation was done at first by a dredge. Then 3 Lidgerwood traveling cableways were installed for the excavation and to deliver stone to the wall, being afterwards replaced by railway inclines, operated by means of hoisting engines and cables. Small locomotives delivered the cars to the spoil bands. Three steam shovels loaded the cars. The cableways were of 10 tons' capacity, and were operated by 75 H. P. hoisting engines with double 12½x15 in. cylinders and a 60-in. drum. The laying of the foundation masonry was begun on May 26, 1896, nine gangs of masons and 12 stiff legged derricks being used that season. During 1907 this force was increased to 17 gangs on masonry and 30 derricks. For the original masonry large rubble masonry was used, with face stones. In 1903 masonry was substituted for an earthen dike, for one wing of the dam, and this wing was built of cyclopean masonry with face stones of granite. All the stone used in this dam was of gneiss or granite. For this addition to the dam, two steel towers 25x50 ft. each were erected, with 4 derricks on each, and were used in placing the masonry.

By covering newly laid masonry with canvas and using a steam jet under the canvas work was carried on during the winter. With the derricks and cableways, during the year 1898 there was laid 158,275 cu. yds. of rubble masonry. From May 1 to Dec. 31, 1904, there was laid 93,452 cu. yds. of cyclopean masonry, the work being done in a very limited area. This was laid with the towers and derricks, the largest month's work being in August, 1904, when 17,000 cu. yds. were placed.

The plant used for this work and its value was as follows:

56 hoisting engines 15 to 25 H. P.	\$33,600
3 10-ton 1,400-ft. cableways, 75 H. P.	30,000
10 10-20 ton locomotives	30,000
8 drainage pumps, ¼ million gals.	8,000
75 5-7 ton derricks	75,000
15 rock drills	4,500
2 pile drivers, 3,000-lb. hammers	1,000
8 concrete mixers, 3 ½-yd. and 5 1-yd.	8,000
3 stone crushers	7,000
3 electric light dynamos	2,000
80 flat cars	12,000
100 dump cars	10,000
750 tons steel rails, 30-40 lbs.	30,000
1 machine shop	7,000
1 sawmill	1,000
1 sand and gravel screening plant	1,000
36 boilers, 10 to 100 H. P.	14,000
3 steam shovels	15,000
1 steam dredge, 80-ft. boom	5,000
75 teams with wagons, carts, rollers, scrapers, etc.	40,000
27 horizontal and vertical steam engines, 10 to 60 H. P.	5,000

6 steam derrick swings	1,800
8 derrick swing attachments	1,200
50 dump buckets	3,000
6 3-yd. derrick skips	600
200 2-yd. derrick skips	4,000
Miscellaneous tools and equipment	20,000
Duplicate parts for repairs	5,000

Total \$374,700

This outfit, or the greater part of it, was used during the life of the contract, which was more than 13 years. The work done with it amounted to \$7,631,185. At the conclusion of the job the contractors stated the plant was in condition to be moved onto another piece of work.

Some German Costs of Manufacturing Brick.

The following figures of the cost of manufacturing brick in three different brick yards are given by Mr. W. Strugel, brick manufacturer, of Kundorf, as quoted in the "Clay Worker." The three yards produce about the same quantity of brick, have the same size kilns and drying arrangements and about the same class of labor. The records are as follows:

The first brick yard has a 50 HP. locomobile. The drying racks are arranged on top of the continuous kiln and hold about 180,000 brick. The brick are brought up by elevators. The continuous kiln has 14 chambers each holding 7,000 brick. The brick are moved on cars. Foreign labor is employed. The press makes 12,000 brick per day, or 72,000 per week. The kiln uses per week seven chambers of 7,000 brick each, which gives 49,000, so that 23,000 are stored for winter use. The following costs are paid per 1,000 brick:

Clay digging, loading of cars and moving to hoist (four men)	\$0.28
Hoisting of the car and moving to press (one man)	0.0675
Charging of the press (one man)	0.0675
Cutting and off-bearing to elevator (two men)	0.14
Taking away from elevator and loading on cars (one man)	0.0675
Moving the cars (one man)	0.0675
Hacking in drying racks and benching (three men)	0.2025
Setting kiln (three men)	0.50
Hacking brick which can not be reached by car (one man)	0.075
Night and day burners (two men)	0.2125
Cleaning of kilns, building doors (one man)	0.05
Engineer (one man)	0.0875
Loading of brick for shipment	0.15
Hacking brick surplus of 23,000 for winter use	0.145
General cleaning expense	0.0375
Repairs	0.0375
Lost	0.1125
Salary superintendent, office expenses	0.375

Total cost per 1,000 brick \$2.6755

In the second brickyard local men were

employed. The machine made 80,000 brick per week, of which the kiln which has a slightly larger capacity took 65,000, so that the winter supply was 15,000 brick per week. The following prices were paid per 1,000 brick:

Clay loading (two men)	\$0.15
Moving to hoist (two men)	0.15
Hoisting the clay	0.075
Charging the press (one man)	0.075
Cutting and off-bearing, loading on cars (two men)	0.15
Moving car to dry sheds (two men)	0.15
Setting kiln (five men)	0.65
Burners (two men)	0.20
Cleaning kilns, building doors (one man)	0.065
Engineer (one man)	0.10
Moving brick	0.025
Loading brick for shipment	0.175
Hacking surplus brick of 15,000 for winter use	0.065
General cleaning expenses	0.0375
Repairs	0.025
Lost	0.075
Superintendency, office expenses	0.375

Total cost per 1,000 brick \$2.6925

In the third yard under observation foreign labor was used exclusively. The drying sheds are all around the kiln. The clay was prepared every day from 5 o'clock to 8 o'clock in the morning for the whole day. The press made 85,000 brick per week, while the kiln took 70,000 brick, so that the excess brick amounted to 15,000 brick per week. The prices paid were as follows:

Clay loading and moving to hoist (two men)	\$0.135
Hoisting and moving clay to press (one man)	0.07
Charging of the press (one woman)	0.045
Cutting brick and loading on car (two women)	0.09
Moving car to dry sheds (one man)	0.0675
Hacking in drying racks (two women)	0.09
Benching	0.0125
Setting kiln (three men)	0.40
Cleaning kiln and building doors	0.0375
Burners (two men)	0.15
Loading brick for shipment	0.075
Hacking surplus brick of 15,000 for winter use	0.04
Cleaning expenses	0.025
Repairs	0.025
Lost	0.065
Superintendent and expenses	0.275

Total cost per 1,000 brick \$1.6675

During the month of June the total reported value of the building permits granted in 45 leading cities was \$39,301,560, 25 per cent below the May, 1907, total. A large decrease, amounting to almost \$9,000,000, is reported for Greater New York, while Pittsburg, Baltimore, and Denver report better results for the month than for May, 1907.

Methods and Costs; Some Old, Some New.

Stop Cock Chambers of Brick.—The Water and Sewerage Department of the city of St. John, N. B., has adopted brick chambers for stop cocks on water mains. Under this plan a brick chamber of elliptical plan, 3x4 ft., is used. The chamber tapers as it ascends and terminates on the surface in a circular hole 2 ft. in diameter. An iron cover is used and gives free access to the gate.

Until recently these cocks were merely buried in the ground with a deal box only large enough for the key, extending from a spindle to the surface. By the old method, when the packing failed or other repairs were required it was necessary to dig a hole.

Maintenance of Arc Lamps in Street Lighting.—In a paper read before the Armour Institute of Technology Branch of the A. I. E. E., Mr. A. B. Cornwell gave the following data on maintenance where a single arc lamp replaces two enclosed arcs for street lighting, costs being for one year:

	Two enclosed arcs.	One flaming arc.
Carbons	\$2.86	\$36.50
Trimming	2.34	8.21
Repairs	1.50	0.75
Inspection	0.90	0.90
Inner Globe	0.60	
Outer Globe	0.30	0.15
Total	\$8.50	\$46.51

A flaming arc has to be trimmed once a day while an enclosed arc needs to be trimmed but once a week.

Cost Data on Painting Wooden Bridges.—The following data, taken from the July Reclamation Record, covers the painting of three wooden bridges on the south canal of the Uncompahgre Project of the U. S. Reclamation Service. The painting was done during the months of December, 1907, and January, 1908, when the weather was quite cold. Two of the bridges consist of four 13-ft. stringer spans, and one 40-ft. span queen post truss, and the other consists of four 15-ft. stringer spans and one 30-ft. span king post truss. The latter bridge and one of the former were constructed of Oregon fir lumber surfaced on both sides, while the other was constructed of rough native pine lumber. The painting consisted of two coats of white lead mixed with linseed oil and shellac. The cost of the first coat in each case was practically twice that of the second coat. The average cost per hundred square feet for the surfaced lumber was \$1.61, requiring 3 lbs. of pure white lead and 0.45 gals. of raw linseed oil. The cost per 100 sq. ft. of surface for the rough lumber was \$3.49, requiring 14.8 lbs. of pure white lead and 1.6 gals. of raw linseed oil. The lead

cost \$0.085 per pound on the work and the linseed oil \$0.55 per gallon.

Centering for Concrete Arches.—In a paper on reinforced concrete bridges read before the Connecticut Society of Civil Engineers, Mr. M. W. Denman, of the Fred T. Ley Co., general contractor, gives the following method of centering: "We use bents of vertical posts which are, in themselves and unbraced, just a trifle too light to carry the load which will be imposed upon them, but which, when fully braced in both directions, will be perfectly rigid during construction. Usually these posts are made up of two pieces in the form of a 'T,' but are wired, not nailed, together. The sheathing over the drum of the arch is made of dressed lumber and made as smooth as possible, although for the average bridge over a waterway I do not think it worth while to attempt too great a nicety here, as it never shows, and strength alone is more to be considered than appearance. It is only essential for such openings that we get it tight enough to prevent undue leaking at the joints. The arch rings we usually run in sections of from 12 ft. and upwards in width, taking such a yardage as we are sure we can run in one day. While that is being placed, the carpenters are building the forms for the spandrel walls, and here the greatest care must be used to obtain sightly results. We have found that forms made of 2-in. lumber, not tongued and grooved, but surfaced on three sides, carefully placed, will give us the smoothest wall. Usually we wet the forms until they are non-absorbent and depend upon thorough spading to produce the smooth surface. At Plymouth, Mass., we built a bridge with walls at each end 36 ft. in length and from 24 to 30 ft. in height. The forms for these walls were made of 7/8 in. tongued and grooved lumber with studding placed closer than usual. These forms we wet lightly with kerosene, spaded the material thoroughly, and the resulting wall is one of the smoothest I ever saw. To get the best results, we much prefer that, before building the wing walls or hand rail, that the earth fill be put on and the centers struck. I do not mean by this their removal, but by the time the fill can be made the arch ring will carry itself, and is putting nearly all the load on the haunches and abutments which is possible. At that time then we take off most of the bracing, and cut the wires on the 'T' verticals, permitting them to buckle under the load, and the arch to assume its final position."

Sheet Pile and Canvas Cofferd Dam.—In the construction of the foundation for a bridge pier, a coffer dam, 19½x61½ ft., inside dimensions, was used. At the point where the pier was constructed the rock bottom averaged from 18 to 23 ft. below ordinary water. Overlying this

rock bottom was several feet of loose shifting sand. The current in the river averaged from six to eight miles an hour. For the coffer dam a single row of 3-ply sheet piling, made of 3x12-in. plank lapped to make a 3½-in. tongue and groove, was used. The piling was spiked and bolted together, and two-thirds of the planks were surfaced to a uniform thickness, the outside plank being left undressed. At the bottom countersunk bolts were used to make sure that the battering on the rock would not crowd them apart. The coffer dam frame was weighed down with scrap iron and guyed in place by two wires. The sheet piling was put down with a light land pile driver, great care being taken to have each pile fit snugly to the adjacent one. After all the piles had been driven to rock, they were pounded lightly so as to broom the ends and make them fit more closely to the irregular rock surface. The piles were beveled to conform to the slope of the bottom as nearly as possible, and they were also sharpened on both edges so the blunt end was about 1½ ins. across. The six corners of the dam had specially designed angles; these were made water tight, driven and securely fastened to the frame work. Driving was then done in both directions from the corners and a closure put in half way between. There were six of these closures, and they were made to wedge in slightly. Canvas was used around the outside of the coffer dam. This apron was of No. 2 duck, edged with 5/8-in. rope, and had eyelets 24 ins. apart for attaching it to the coffer dam. The eyelets were so arranged that the load came on the rope edge. The canvas was made up in four pieces, so arranged that the lower apron laid flat on the river bottom for 8 ft. out from the dam, and the upper part extended above water level to prevent the water getting behind it. Difficulty was experienced in placing the canvas because of the swift current, but with the outer edges weighted with scrap rails and sand bags, and by using rails suspended horizontally from ropes and moving them up and down the side of the dam, the canvas was placed. It was found desirable, however, to first sew the four pieces together. About 50 car loads of gravel were then placed on it. The leakage was almost entirely around the bottom where the sheet piling encountered loose rock, and when the dam was finished this leakage was kept down so that an 8-in. vertical centrifugal pump was more than sufficient to handle it. The leakage perhaps would have been still less if the sand and loose rock had been removed from under the lower apron of the canvas.

Toronto, Ont., has voted to construct a trunk sewer system to cost \$2,450,000 and a water filtration plant to cost \$750,000.

The American Institute of Chemical Engineers.

A new society of chemists to be known as the American Institute of Chemical Engineers was formed at the Engineers' Club in Philadelphia on Monday, June 22. About twenty-five prominent chemical engineers were present, some coming from such distant points as St. Louis, Mo., Richmond, Va., Syracuse, N. Y., etc. About three times as many more were represented by applications for membership. In this latter group, are included most of the prominent chemical engineers of the country.

The objects of the Institute as set forth in its constitution are:

To advance the cause of applied chemical science.

To give the profession of Chemical Engineers such standing before the community as will justify its recognition by Municipal, State and National authorities in public works.

To raise the professional standard among Chemical Engineers, discouraging and prohibiting unprofessional conduct.

To co-operate with educational institutions for the improvement of the education of the men who are to enter this profession.

To encourage original work in chemical technology.

To promote pleasant acquaintance and social and professional intercourse among its members.

To publish and distribute such papers as shall add to classified knowledge in chemical engineering and shall increase industrial activity.

According to the constitution active membership shall consist of but one grade and shall require the following preparation and training:

All candidates must be not less than 30 years of age and must be proficient in chemistry and in some branch of engineering as applied to chemical problems and must at the time of election be engaged actively in work involving the application of chemical principles to the arts. All candidates for admission to this Institute are expected to have expert knowledge of at least one branch of applied chemistry, and must fulfill one of the following requirements:

1. Candidates who hold no degree from an approved university or technical school must have had ten years' experience in chemical technology; five being in responsible charge of operations requiring the elaboration of raw materials, the design of machinery involving chemical processes or the application of chemistry to industry.

2. Candidates who hold the degree of A. B. (Bachelor of Arts) from an approved university or technical school offering a four-year course must have at least eight years of practical experience as outlined under No. 1.

3. Candidates who hold the degree of Ch. E. (Chemical Engineer), B. S. (Bachelor of Science) in Chemistry or Chemical

Engineering or E. E. (Electrical Engineer), C. E. (Civil Engineer), or M. E. (Mechanical Engineer), or equivalent degrees from an approved university or technical school offering at least a four-year course, must have at least five years' practical experience as outlined under No. 1.

4. For candidates who in addition hold the degree Ph. D. (Doctor of Philosophy) or Sc. D. (Doctor of Science) in Chemistry, the number of years required to earn the higher degree may be deducted from the number of years of experience required.

The officers of the Institute are as follows:

President—Samuel P. Sadtler, I.L. D., of Philadelphia, Pa.

Vice-Presidents—Charles F. McKenna, Ph. D., of New York, N. Y.; H. Aug. Hunicke, Ph. D., of St. Louis, Mo., and Edward F. Achison, of Niagara Falls, N. Y.

Treasurer—Wm. M. Booth, M. S., of Syracuse, N. Y.

Secretary—John C. Olson, Ph. D., of New York, N. Y.

Auditor—Richard K. Meade, M. S., Nazareth, Pa.

Directors—To serve one year, Ludwig Reuter of Berkeley, Cal.; Thoree Smith, of Isabella, Tenn., and H. F. Brown, of Wilmington, Del. To serve two years, Eugene Haanel, of Toronto, Can.; J. M. Camp, of Duquesne, Pa., and C. A. Catlin, of Providence, R. I. To serve three years, George P. Adamson, of Easton, Pa.; David Westman, of Montclair, N. J., and E. F. Gude-man, of Chicago, Ill.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0809. *Mine Fans*.—Jeffrey Mfg. Co., Columbus, Ohio.

A 24-page well printed catalog on a fine quality of paper. Illustrates various installations of mine fans and gives plans of placing fans to suit many conditions. Also contains various engineering formulas used in determining different features of mine ventilation. This company style themselves "Builders of complete coal mine equipment."

No. 0810. *Waterproofing and Cements*.—Clifford L. Miller & Co., 110 East 23rd St., New York.

A small pamphlet telling of the uses of marble and stone cementing compounds, the Medusa White Portland Cement, Medusa Waterproofing and mineral products for use on light vaults, etc.

No. 0811. *Cableways*.—Lidgerwood Mfg. Co., 96 Liberty St., New York.

A beautifully gotten up catalog, 9x12 ins. in size, of 165 pages. Illustrations of many plants in operation add to the attractiveness of the book. The use of cableways is shown in building canals, power house, dams, dry

docks, locks, filter beds, concrete buildings, piers, bridges, fortifications and sewers, and for handling coal on land and at sea, saving life at sea, quarrying, open pit mining and log handling. These cableways have been used for many purposes and in all parts of the world.

No. 0812. *Foundry Supplies*.—Whiting Foundry Equipment Co., Harvey, Ill.

A 32-page catalog issued by this company as a reference catalog for foundry supplies and equipment. They issue a general catalog and a number of special catalogs, but in this pamphlet all supplies needed in the modern foundry from a 30-pound ladle to a 200-ton electric crane are listed. Many of the tools and machines shown can be used in contract work as well as in foundries.

No. 0813. *Dump Buckets*.—The Cyclopean Iron Works, 402 Claremont Ave., Jersey City, N. J.

A 24-page catalog of dump buckets, showing various styles of buckets made by this company. Also scale boxes, and small dump cars, coal chutes and screens. A table showing sizes, weights and net prices of buckets is given.

No. 0814. *Dump Buckets*.—The Union Iron Works, Hoboken, N. J.

A 50-page catalog issued by this company on dump buckets, and apparatus for the rapid and economical handling, hoisting, loading and conveying of materials of various kinds. Under this head are listed buckets of many patterns, dump cars, charging and platform cars, industrial railways, barrows of many kinds, derrick and cableway skips, coal chutes and screens, trucks, turntables and electric railway conveyors. Price lists are given.

No. 0815. *Railway Converter Substations*.—General Electric Co., Schenectady, N. Y.

This 24-page pamphlet gives a general description of the various pieces of sub-station apparatus, including rotary converter transformers, reactances, blowers, cables, switchboards, etc., and includes illustrations of converter stations operated by various well-known railway companies. It contains also plans and elevations showing different arrangements of sub-station apparatus.

No. 0816. *Spring Lock Steel Sheet Piling*.—The Canton Bridge Co., John Newell, General Agent, Albany, N. Y.

The essential portion of this pile is the spring lock. This detail is simple—two curved bars riveted to any stock material—a 20-in. plate arbitrarily selected as our standard. The curved bars slightly interfere—consequently springing a fraction of an inch in driving—making three points of absolute contact; a positive bearing and a resulting water-tight joint.

No. 0817. *Mallet Articulated Compound Locomotives*. By Grafton Greenough, Baldwin Locomotive Works, Philadelphia, Pa.

This 44-page pamphlet is an excellent historical descriptive account of the development of articulated locomotives, with a discussion of their principles and a special consideration of Mallet locomotives. The paper is elaborately illustrated by line drawings of structural details. There is also an interesting discussion by Mr. S. M. Vanclain.

No. 0818. *Dipper Dredges*.—The Fairbanks Steam Shovel Co., Marion, Ohio.

A new, neatly printed and attractive catalog of 64 pages. The Fairbanks dipper dredges for various purposes and of several sizes are described and illustrated and methods of operation shown. Also a traction steam shovel, a contractor's locomotive crane especially designed for sewer work, traction engines for hard usage, and dry land excavators manufactured by this company. Every contractor should have this catalog.

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The Georgian Bay Ship Canal.

Fairly complete official information is finally available regarding the proposed new Canadian deep waterway from the Great Lakes to the Atlantic Ocean, which has come to be known as the Georgian Bay Canal. This enterprise was first brought into prominence some 15 years ago by private persons who planned to connect the head of Georgian Bay on Lake Huron by canal with the St. Lawrence River near Montreal and thus permit lake vessels to

sail direct to European ports. Several years ago the Canadian Government took up the enterprise and started a careful survey of the available routes. This survey has been completed and its results made public in a report to Parliament by the Canadian Minister of Railways and Canals. With this report the Georgian Bay Canal project arrives at a stage of progress which makes it of definite interest to contractors, and we summarize briefly here the main construction features of the work.

The purpose kept in mind throughout the survey has been a waterway capable of accommodating lake vessels of large size 600 x 60 ft. x 20 ft. draft. This means a channel 22 ft. deep and locks at least 650 x 65 ft. in dimensions. The routes surveyed are substantially as follows: From Georgian Bay via the French and Pickering rivers and Lake Nipissing and thence 3½ miles by artificial canal to Trout Lake, the Little Mattawa River and Talon Lake. From Talon Lake there is a 3-mile canal cut to the Mattawa River, which is followed to Mattawa, whence a ¾-mile canal cut leads to the Ottawa River, which is followed to the foot of the Lake of Two Mountains. From Lake of Two Mountains two routes are possible, one by the St. Lawrence River and one by the Ottawa River, or Riviere des Plaines. The total distance as outlined is some 440 miles.

The total length of what may be termed canal cutting for the entire route is about 28 miles, by the project connecting the St. Lawrence River above Montreal, through Lake St. Louis, and 34 miles should the Riviere des Prairies route be selected.

The length of submerged channels to be excavated is about 60 miles in stretches of varying lengths. Apart from this there is an aggregate of 14¼ miles where obstructions such as shoals, sharp bends, etc., have only to be removed to form very wide channels.

Therefore, of the 440 miles constituting the waterway, 108 miles will require excavation work for locks, approaches, canals, submerged channels, etc., leaving 332 miles of natural river or lake channels, which will not require any improvement beyond the raising of the water surface. Taking into account the 14½ miles of obstructions which, after removal, will leave wide, free channels, the route may be subdivided as follows, in relation to width: Miles.

Canal cuts, 200 to 300 ft. wide, including necessary restrictions at locks...	28
Improved channels, submerged sides, 300 ft. wide	66
Free channels, 300 to 1,000 ft. wide and over	346
Total	440

The relative length of canals and submerged channels may be varied slightly as it is an open question as to the exact point where the one ends and the other begins.

The mileage of excavation in canals and channels for the route may be subdivided

as follows for each class of material encountered:

Dry excavation—Rock, about 25 miles; earth, about 13 miles; mixed earth and rock, about 20 miles; total, about 58 miles.

Wet excavation—Rock, about 18 miles; earth, 16 miles; mixed earth and rock, 16 miles; total, 50 miles; grand total, 108 miles.

This mileage includes all points which are to be dredged or excavated, whether canal cuts, submerged channels or shoals.

The difference in elevation of 659 ft. between Montreal and the summit level, and of 90 ft. between the summit and Georgian Bay is overcome by 27 locks ranging in lift from 5 to 50 ft. By the Riviere des Prairies route, however, this number is reduced to 26. All locks are designed to be built of concrete.

The navigation scheme requires the building of 45 dams of various sizes, not including those which will be required in connection with the system of storage reservoirs. Generally, where the quantity of water is much above the canal requirement, the rock-filled type of dam has been adopted. Where, however, it is important to economize water for lockages, concrete dams have been designed. The estimated cost is based on these two kinds of dams and the stop log system of regulation of sluices has been adopted throughout, with the exception of a few locations where Stoney sluices are deemed necessary.

A careful analysis of the work to be performed shows that it would take from three to five years to develop all contracts and place the whole route under active construction. Some of the sections where heavy submarine excavation is encountered would require at least five years to complete under the best conditions of labor and equipment. It may be fairly stated, therefore, that a period of ten years from inception would be necessary to open the waterway to navigation. This would mean an average expenditure of about ten million dollars per year.

The cost of the canal is estimated at \$99,689,000 if the route via Ste. Anne de Bellevue, Lake St. Louis and the St. Lawrence River is followed to Montreal. If, however, the other mouth of the Ottawa River, known as Riviere des Prairies, is followed, the cost is estimated at \$93,890,000. In either case \$900,000 will have to be spent for a feeder at the summit of the canal, when this is required.

The preceding abstract touches upon only the salient constructional features of the proposed new Canadian deep waterway, but it brings out clearly the interesting fact that for less than \$100,000,000 it is possible to open up the interior of not only Canada but of the United States to ocean going vessels of very considerable size, and thus makes possible the shipment by vessel of cargoes from Chicago and Duluth direct to European ports without break of bulk or change of bottom.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Methods and Some Costs of Constructing a Reinforced Concrete Arch Bridge.

BY JOHN HARNES.*

The bridge has a roadway 30 ft. wide in the clear, and two sidewalks 8 ft. wide each. The length of the bridge is 306 ft. divided as follows: 20 ft. for each abut-

ment, of nine rows of five piles each for outer arches, and ten rows for center arch. After piles for first arch were driven, pile driving for pier No. 1 was started. This being finished, jetting of sheetpiling for the pier was started. Up to this time the water in the river was as low as 2 ft., making it impossible to float any craft, and so cribwork had been used for handling

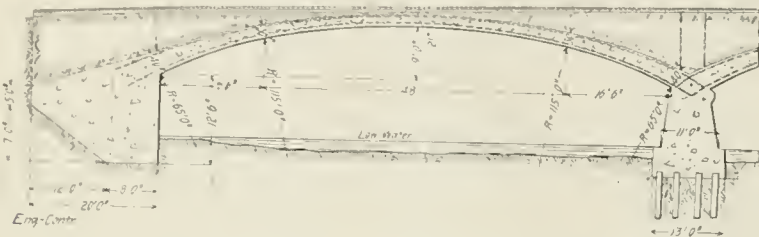


Fig. 1—Longitudinal Section of Reinforced Concrete Arch Span.

ment, 81 ft. for each outer arch, 88 ft. for center arch and 8 ft. for each pier. The reinforcement used in the arches is 1 in. twisted steel, 2 ft. c. to c. in two rows, $1\frac{1}{2}$ ins. from extrados and intrados and tied to $\frac{1}{2}$ in. square transverse rods every 5 ft. The reinforcement of the overhanging sidewalks is of expanded metal No. 4 gage 6 in. mesh, which is turned down at the outer edge for about 4 ins. and fastened to a $\frac{3}{4}$ in. square rod, and on the inner edge is hooked to a 1 in. twisted rod which is anchored with $\frac{1}{2}$ in. twisted rods to the bottom reinforcing rods of the arch, as shown by Figs. 1 and 2.

The thickness of concrete of the arches is 40 ins. for the outer arches at haunches, 30 ins. at a distance of 16.5 ft. from haunches and 21 ins. at the crown. For center of the arch the thickness is 42 ins. at haunches, 30 ins. at distances of 16.5 ft. from haunches and 22 ins. at the crown.

The piers are of monolithic construction. The upstream and downstream ends form a sharp point, reinforced with blocks of brown stone, cut to the proper angle to break the ice. Piers and abutments were built up to an elevation of 9.5 ft. above low water mark. Since the bed of the river is soft mud, each of the piers was built on a foundation of 60 piles driven 3 ft. c. to c. and cut off at an elevation of 2 ft. below M. L. W.

On account of the kind of soil it was necessary to drive piles for the falsework, and this was begun at the same time as the jetting for the sheetpiling of the abutment. The piles for falsework consisted

of the pile driver. Heavy rainfalls raised the water to 10 ft. and caused at times such strong currents that the work had to be stopped. This brought the cost of labor much higher than it would have been under ordinary circumstances. The cost of jetting the sheetpiling on the pier is given further on. After the sheetpiling was all

concrete up to M. L. W., and on this foundation the forms for the pier were built.

At this time excavation for abutment No. 1 was finished and a Koppel industrial railway had been laid. This railway was laid on a temporary trestle across the river and was provided with switches to reach abutments and piers.

Sheetpiling of the abutments served as forms up to about 4 ft. below the spring line. Above this point, forms of 2 in. spruce were built. The designing of an 18 in. crown molding on all piers and abutments at the height of the spring line of arches made the forms rather expensive. The concrete in the abutment was finished in broken layers on the arch side to give a good bond between arch and abutment. While the concreting on abutments and piers was being done, the building of falsework for the first arch had proceeded.

The construction of this falsework was as follows: Piles were cut off at a height of 3 ft. below the bottom line of the concrete arch. On these piles were placed, transverse to the arch, two 6 x 12 in. caps, spiked to piles well spliced together at joint in center, and overhanging about 6 ft. at outside. An upper cap was made of two 6 x 12 in. timbers. Between the two caps oak wedges were placed about every 5 ft. On top of the upper caps were placed 3 x 12 in. floor beams 2 ft. 8 in. c. to c., cut on top to proper line of arch. A 2 in. spruce floor was nailed to these floorbeams (see Fig. 3).

It may be well to remark here that the centers were laid out full size on a large platform, and patterns were made of 1 in. pine boards for all floor beams and side

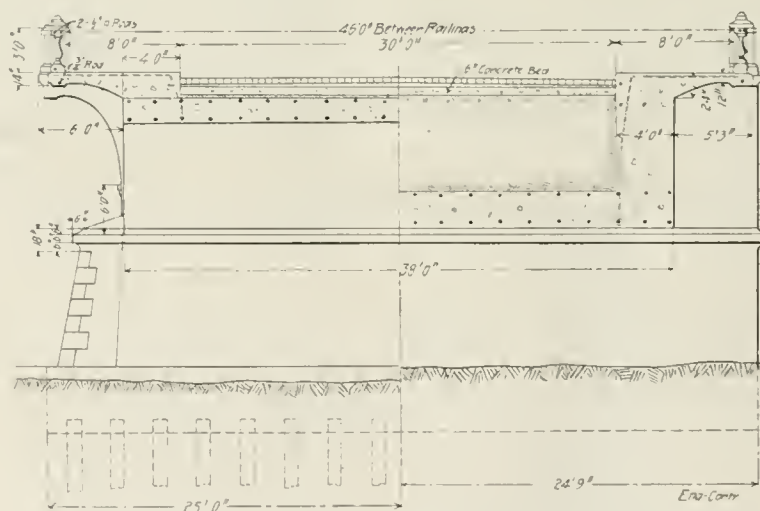


Fig. 2—Transverse Sections of Reinforced Concrete Arch Span.

driven and properly shored for heavy water pressure a centrifugal pump was installed, driven by the pile driver engine, and the enclosure was kept dry until concrete was in place. Excavation was extended to 3 ft below low water mark and the piles cut off 2 ft. below the same level, so as to enclose them in about 12 ins. of concrete. The whole space was then filled in with

forms of arches. The cutting of all the floor beams was done by a 12 in. circular saw, which was run by a belt connected to the hoisting engine which pulled the cars up the incline to the mixing platform.

The different radii of the arches made the curves of the floor beams vary to such an extent that the amount of framing of center done per day varied a

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great deal. The side forms of arches were made of 2 in. spruce and built in sections of 7 ft. In this way the placing of forms was done quickly and cheaply. The specifications stated that the concreting of the arches should be done in ribs of such a width that one complete rib of the arch could be finished in a day. Three more forms similar to the outside forms were made and so placed as to divide the arch into five equal ribs.

Since it is important to have reinforce-

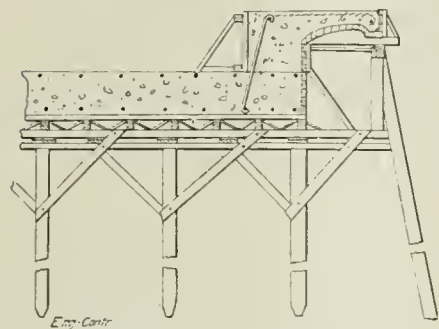


Fig. 3—Forms and Falsework for Arch, Spandrel Wall and Sidewalks.

ment at the proper distance from intrados and extrados, little cement blocks of $1\frac{1}{2}$ in. thickness were made to hold the bars at the proper distance from the bottom. The advantage of using concrete blocks instead of wooden blocks, as is usually done, is easily understood. The blocks, being of concrete, stay in place, require no pointing up afterwards, and the cost of making them is about $\frac{1}{2}$ ct. each.

After placing upper longitudinal bars, sticks were used to hold those in place, but the writer proposes on future jobs to make concrete blocks as shown in Fig. 4. The cost of such a block the writer believes would be small, while its efficiency would be such as to make it economical.

As shown in plan, Fig. 2, the reinforce-

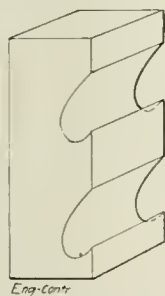


Fig. 4—Concrete Block to Hold Steel Rods in Place.

ment of spandrel walls and overhung sidewalk was anchored to the lower rods or arch, and the 1 in. rod was suspended at the proper height on wooden brackets nailed to the outside of the arch forms. From this bar, $\frac{1}{2}$ in. twisted rods were run to the lower rods, every 18 ins., being hooked on both rods by turning the ends.

Pile driving and sheetpiling had been going on, and when high water caused this work to be stopped, concreting of abutment No. 2 was done.

The industrial railway proved of great value during all this time for handling materials in an economical way.

It may be well to mention the method used for handling the materials. The stone and sand had to be stored on building lots about 250 ft. away from the proposed bridge. A platform 14x16 ft. was built about 60 ft. from this place at an elevation of 16 ft. Under this platform

The tracks had a down grade of about 4 ft. to a length of 150 ft.

This brought the rails at the proper height for dumping concrete into piers and abutments, and at the same time, gave the cars enough momentum to require but little pushing.

After finishing the piers and abutments to the spring line, the track was removed and laid to the arches. Heavy timber was

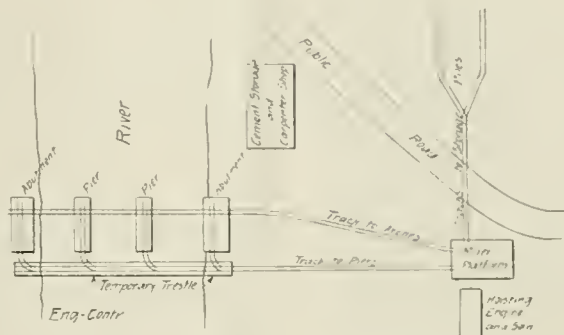


Fig. 5—Layout of Construction Plant.

was placed a Smith mixer, blocked up on timbers, high enough to allow of dumping into the Koppel side dumping cars. A timber trestle was built extending from stone and sand pile to the top of the platform and an industrial railway laid on this. Cars were pulled up the incline by a hoisting engine stationed back of the mixer. See Fig. 5. A switch was placed at the bottom of the incline, making it possible to work two cars. Those cars were marked to give the proper quantities of sand and stone for a $\frac{1}{2}$ batch proportioned 1-3-6. Atlas cement was used and

placed across the arch forms on which were laid longitudinal timber to carry tracks. At the crown of the first arch the track was elevated and cars were pulled up this grade by the hoisting engine, from which point they proceeded by their own momentum. On the crowns of the first and center arches, switches were put in, and by this arrangement three cars were handled so rapidly that at no time did the mixer have to stop on account of there not being cars available.

The plant proved sufficient to do the work in remarkably short time. The



Fig. 6—View Showing Placing of Concrete for Arches.

as it was taken from the storage house it was put on the cars in bags enough for every batch, and opened and emptied at the platform. Each car furnished also all the materials required, and in this way an output was obtained of 35 to 40 batches per hour. Starting from the mixer was the other industrial railway previously mentioned. The elevation of track at the mixer was 14 ft. 3 ins. above M. L. W.

time from beginning concreting of first arch until the third was finished, including the erection of all falsework and forms for the last two arches, was only 20 days. All the concrete was placed in 15 days, working not longer than 7 hours a day. If four ribs instead of five had been made in each arch, the results would have been even better, but this would have meant taking a great risk, on account of doubtful

weather at this season of the year and also in case of any breakdown of machinery.

The building of falsework for the sprandel wall and overhanging sidewalk proved difficult and was by far the most expensive of all form work.

This falsework was constructed by resting one side on posts placed on the caps of the falsework of the arches, while the other side was held up by posts placed at a slight angle and rammed in the mud of the river bottom. These posts and the caps on them were 8x10 in. timbers. On these caps 3x12 in. floor beams were placed 3 ft. c. to c., being covered with 2 in. spruce flooring, cut into 4 in. strips, the edges being tapered to make tight joints. The whole falsework was well braced. At all corners of forms, molding was nailed to the forms to round off the corners of the concrete. Panel effects in the concrete were also made by nailing battens to the forms. These pieces were generally planed.

Each arch had expansion joints of $\frac{3}{8}$ in. at both ends and also at a distance of 24 ft. 3 ins from both ends. Each expansion joint was made up of $\frac{1}{4}$ in. corrugated paper covered on both sides with 3-ply tarpaper. The balusters for the railway were all made on the job, there being 350 required, and for this purpose eight forms were made. These were made in four parts each and were held together with bolts so that removing the form was easily done.

The base of these balusters was 8x8 ins., the height being 2 ft. As previously stated, eight forms were made for this work. The forms were made on the job. The entire labor cost of making the balusters was:

Carving white wood blocks, 1 man 12 days at \$3.....	\$ 36.00
Making 8 forms, 1 man 12 days at \$2.75	33.00
Making and finishing balusters, 1 man 35 days at \$2.75.....	96.25
Total	\$165.25

A man made 10 balusters per day. The cost for forms was 19.7 cts. per baluster, and for making and finishing, each 27.5 cts., giving a total cost for labor of 47.2 cts.

In jetting down the sheet piles, which were 2x8 ins. x 20 ft. long on an average, 100 pieces were put in place per day, or 1 piece every 6 minutes. This does not include moving machine from one pier to another, but does include moves while working on a single pier. The labor cost was:

1 Foreman	\$ 5.00
1 Engineman	3.50
2 Hosemen at \$3.50.....	7.00
2 Men preparing piles at \$2.50.....	5.00
7 Helpers at \$1.75.....	12.25
Total	\$32.75

There being 2,000 lin. ft. of piling or 2,666 ft. B. M. gives a unit cost of 16/10 cts. per lin. ft. and \$12.25 per M. ft. B. M. for the labor.

The labor costs for forms for the sprandel wall and overhanging sidewalk on the two sides of an arch were:

Foreman carpenter at \$5.....	\$ 20.00
Building falsework:	
2 Carpenters at \$3.50.....	28.00
3 Men at \$2.....	24.00
Building forms:	
2 Carpenters at \$3.50.....	28.00
6 Carpenters at \$3.....	75.00
2 Carpenters at 2.75.....	22.00
3 Helpers at \$2.....	26.00
Total	\$223.00

There was about 12,000 ft. B. M. of lumber used in these forms, thus giving a cost of framing and erecting per M. ft. B. M. of \$18.60. With 180 cu. yds. of concrete put in these forms the cost per cu. yd. was \$1.24 for the labor on the forms.

The cost of erecting the forms for the arch, exclusive of the piling, was:

Foreman carpenter 6 days at \$5....	\$ 30.00
Falsework, 8,300 ft. B. M., erecting crew:	
2 Men at \$3.50.....	\$ 7.00
2 Men at \$2.50.....	5.00
2 Men at \$2.00.....	4.00
2 Men at \$1.75.....	3.50
Total 4 days at	\$19.50

Floor beams, 5,960 ft. B. M., carpenter crew:	
2 Men at \$3.50.....	\$ 7.00
4 Men at \$3.00.....	12.00
3 Men at \$2.75.....	8.25
1 Man at \$2.00.....	2.00
2 Men at \$1.75.....	3.50
Total 2 days at	\$32.75

Erecting crews 2 days at \$19.50....	39.00
Forms, bottom and sides, 11,000 ft. B. M., carpenter crew:	
Framing forms 2 days at \$32.75.....	98.25
Setting forms 2 days at \$32.75.....	65.50
1 man making patterns, 3 days at \$3.50	10.50
Total	\$386.75

There was 25,000 ft. B. M. of lumber in the falsework and forms exclusive of the piles, which makes a cost per M. ft. B. M. of \$15.47 for this labor. As there was 365 cu. yds. in an arch this gave a cost of \$1.06 per cu. yd. for this labor.

In mixing and placing the concrete for the arches, one rib was done in a day so that it would be monolithic. There were 73 cu. yds. in a rib. The following was the cost of labor per day when mixing and placing was being done;

1 Foreman	\$ 5.00
1 Sub-foreman	3.50
1 Engineman	3.50
1 Man running mixer.....	2.50
1 Concrete placer	2.75

4 Concrete placers at \$2.50.....	10.00
6 Men on cars at \$2.....	7.80
2 Men on mixer platform at \$2....	4.00
1 Man at stock pile.....	2.00
22 Men shoveling at \$1.75.....	38.50

Total **\$79.55**

The actual time of placing a ring was from 6 to 7 hrs., thus giving a cost of mixing and placing of 85 cts. per cu. yd. When the concrete work was done, some of the crew was knocked off, and the rest were kept busy in changing tracks and other details. As stated, a larger ring could have been placed in a day, but the risk of some unforeseen accident that may have held up the work was considered too great to take. Fig. 6 shows how these rings were cast.

A landing stage, designed especially to meet the conditions of the 22-ft. tide at Culebra Island Quarantine Station in Panama bay, has been completed at the Gorgona shops, and will be erected at the quarantine station by the Division of Municipal Engineering. It is composed of three parts, a fixed bridge, a float, and a movable bridge or gang plank, joining the float with the fixed bridge. The fixed bridge is a wooden structure, 26 ft. above the low water mark, with one end resting on the island and the other on a cast iron pier. The float is a steel hull of barge construction, 47 ft. 4 in. long and 12 ft. wide, containing 52,000 lbs. of steel and with a 3-in. plank deck. Heavy oak timbers, bolted to two cast iron piers, hold the float in place and allow it to rise and fall with the tide. Each of these piers is made up of nine sections of cast iron cylinders, each 9 ft. in diameter and 6 ft. 6 in. long. These cylinders were left on the Isthmus by the French and are a part of a hydraulic ship-lift designed by M. Eiffel as an improvement on the common form of lock. The movable bridge is hinged to the fixed bridge at one end, while the other end rests on the float. It is 118 ft. 6 in. long and was rebuilt at Gorgona from a section of a conveyor outfit left by the French at Tabernilla. It is a steel frame with a plank walk 7 ft. wide. The cost of the float was \$5,480.06, of which \$2,012.53 is for material; \$2,667.33 for labor, and \$800.20 for supervision. The labor cost on the hull, according to the Canal Record, was two and one-half cents a pound. Work was begun on the stage April 30, and shipment was made June 15. Seven cars were required to carry it over the Panama railroad from Gorgona to La Boca, whence it will be towed out to Culebra Island.

A large stripping contract was recently awarded to the Ferguson Contracting Co. of New York City. The contract called for the stripping of about 12,000,000 cu. yds. of earth from phosphate beds at Mulberry, Fla.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost of Excavating Earth With an Electrically Equipped Shovel.

The Brantford & Hamilton Electric Railway Co. of Hamilton, Canada, has installed a Thew shovel, operated by electrical power, to work on the construction of an extension of its lines. Through the kindness of Mr. C. K. Green, manager of the railway company, we are able to give some records of this shovel's operation and the cost of some of the work that has been done.

The shovel is a No. 1 type, manufactured by The Thew Automatic Shovel Co., Lorain, Ohio. It weighs 25 tons, and has a radius of cutting at a height of 9 ft. of about 24 ft. This style of shovel, mounted on a railroad truck, as shown in Fig. No. 1, has a full circle swing. The hoisting, swinging and crowding motions are controlled by separate engines. It was equipped with a 35-h. p. shunt wound direct current motor furnished by the Canadian Westinghouse Co. The current is received through the truck by wire cables as plainly shown in the photograph, and in transmitted to the motor above through copper rings on the truck frame and carbon brushes suspended from the swinging turn table above. Either direct or alternating current motors can be used on these shovels. A 1 cu. yd. dipper was used on the shovel. Two men were used on the shovel, one for operating and the other for tripping, the men changing places frequently.

The conditions under which this shovel was worked were most favorable. It worked in a gravel pit, the depth of the cutting being about 14 ft. The material was very easy to handle. The pit was very long, so the shovel did not need to be shifted often, and inasmuch as it makes a complete swing, the time of shifting was very short. A special trolley wire was used for the motor in the shovel, so that the current was constant. This is an important feature of an electrical installation. No time was lost in moving the shovel ahead, as the two men working in the pit would clean out a space directly in front of the shovel, when the machine would pick up a section of track in the rear and place it in the newly cleaned space. While the two pitmen were fixing this piece of track the shovel would take gravel from the side, so that not more than a minute was required to move the shovel ahead.

The company had an ample supply of flat cars on which were loaded 14 cu. yds. loose measurement. There were also

plenty of motors to haul the trains away, six cars making up a train. One motor car was used to spot the cars continuously, and a man was employed as a signalman to assist in spotting cars. The shovel worked a ten-hour shift, and any repairing and overhauling was done at night by another crew. Operating in this manner, as a rule, the shovel was loading the maximum time, there being but little time lost in placing cars under the dipper and in moving ahead. With the electrical current no time was lost in taking supplies of water and fuel.

The trains that carried the gravel away



Electrically Operated Shovel.

were operated by a motorman and one other man. A plow, pulled by the motor car, was used to unload the cars, and two men were kept on the dump to handle the cable of the plow and to attend to other details.

Owing to the large supply of cars and motors, to the favorable conditions in the pit and the method of operating, the output of the shovel per day did not vary much. A great many days 100 flat cars were loaded each day and hauled away. This meant an output of 1,400 cu. yds., loose measurement, or 1,050 cu. yds. place measurement.

With the following wages:

Superintendent	\$ 4.00
Shovelmen	3.00
Pitmen	1.50
Motormen	3.00
Trainmen	1.50
Dumpmen	1.50

We have a labor cost for operating per day as follows:

Superintendent	\$ 4.00
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Shovel crew:

2 shovelmen	6.00
2 pitmen	3.00

Spotting cars:

1 motorman	3.00
1 signalman	1.50

Transporting (2 trains):

2 motormen	6.00
2 trainmen	3.00

Dump:

2 men	3.00
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Total\$29.50

With 1,050 cu. yds. moved per day we have the following unit cost for labor:

Superintendence	\$0.004
Loading	0.013
Transporting	0.009
Dumping	0.003

Total\$0.029

To this must be added charge for power, plant charges, repairs and track work. When the haul increased in length addi-

tional trains were added, so that the shovel was still kept busy loading the cars.

On some days the output fell to 80 carloads or less. With this output, namely 800 cu. yds. place measurement per day, the unit labor cost was:

Superintendence	\$0.005
Loading	0.017
Transporting	0.011
Dumping	0.004

Total\$0.037

The above show low records of cost for steam shovel work, but they make evident the economical features of excavating with a shovel of this type, as small and inexpensive crews are employed, and a comparatively large output can be obtained by using the best methods of operating.

Washington was the largest producer of lumber for 1907, producing 3,777,606 M. ft. B. M. The next largest producer was Louisiana, which reported 2,972,119 M. ft. B. M.

Examples of High and Low Cost of Wheel Scraper Work, with Comments on the Efficiency of Work Done.

In carrying on earth excavation, the cost may vary exceedingly, caused by either the local condition surrounding the work, or by the management displayed in carrying it out, or by both. This fact is well illustrated by the following examples of wheel scraper work.

Example I.—The wages paid for a ten hour day were:

Foreman	\$3.00
Plow-team, driver and helper.....	9.20
Snatch team driver	6.00
Scraper team and driver	4.75
Loaders	1.60
Dumpmen	1.50
Water boy	1.00

The cost per cu. yd. for doing the work in detail was:

Foreman	\$0.036
Scraper	0.270
Plowing	0.110
Snatching	0.072
Loading	0.038
Dumping	0.036
Water boy	0.012
Total	\$0.574

This work was on a job of railroad construction. The ground had just been cleared, but as the cut was only from 4 to 5 ft. deep at the highest point, the roots and stumps interfered somewhat in the work. The material was stiff red clay and was wet and heavy, so much so that it was impossible to heap the scraper when loading. No. 2½ wheelers were used and a 3 horse snatch team. A 4 horse plow team was used and 2 men loaded the scrapers, while 2 men worked on the dump, which was across marshy ground. The lead was 800 ft., while the haul, that is, the distance traveled in making each round trip, was 1,000 ft. Five scrapers were worked, and a scraper moved 18 cu. yds. per day, while the cu. yds. moved for each team of two horses worked, was only 10. Each scraper team traveled about 10 miles per day.

Example II.—The wages paid for a ten hour day were:

Foreman	\$3.00
Scraper team and driver.....	4.75
Plow team, driver and helper.....	9.50
Snatch team, driver and helper.....	7.50
Loaders	1.60
Dumpmen	1.50
Water boy	1.00

The cost per cu. yd. for doing the work in detail was:

Foreman	\$0.008
Scrapers	0.117
Plowing	0.027
Snatching	0.021
Loading	0.009
Dumping	0.008
Water boy	0.003
Total	\$0.193

This scraper work was likewise done in grading a railroad. The ground was free of roots. The material was a sandy clay, easily handled, and loaded onto the scraper pan well. No. 2½ wheelers were used, and a 3 horse snatch team with two men, one to drive the team and the other to hook them and unhook them to and from the scraper. Two men loaded the scraper and two men were employed on the dump. A 4 horse plow team was used. The lead was 800 ft., while the haul was 875 ft. A scraper team traveled about 20 miles per day, which means a rapid walk, with both the loaded and empty scraper. A No. 2½ wheeler will carry ⅓ of a cu. yd. of earth, place measurement. This is confirmed by Gillette's "Earth Work and Its Cost," page 55, where a table of capacities of wheel scrapers is given. Nine scrapers worked in a gang, and each scraper moved 40.5 cu. yds. per day, an exceedingly good day's work. This gave an average yardage for each team worked of 20 cu. yds.

A comparison of these two examples shows a woeful difference in efficiency of work done. In the last example each scraper traveled twice the distance that a scraper did in the first example, and moved more than twice the yardage, this addition to the yardage being made possible by the length of haul being less, although the length of lead was the same in both cases. In example No. I, only 5 scrapers were used in the gang, while in No. II 9 scrapers were used, which was enough to keep the loading gang working continuously. The use of only 5 wheelers meant that part of the time the loading crew was idle, and this naturally gave a slow pace to all the work. The snatch team in the first case was driven by a man, who also had to hook and unhook the team to the scraper, while in the second case another man did this, saving time and allowing more work to be done. In the first case, the snatch team loaded 220 scrapers in a day, while in the second example nearly 1,100 scraper loads were handled by the snatch team. This meant that only a little over half a minute was consumed in loading.

The plow team loosened in the first example only 90 cu. yds. per day, while in the second case they loosened about 365 cu. yds.

The conditions surrounding the first work were adverse ones, while in the second case they were all favorable, besides there were not enough scrapers in the first gang.

These things all added to the cost of the work, as compared to example No. II, but the poor standard of work done in the first case, in the number of scrapers used, can be attributed to the foreman. The good work was done by an experienced railroad foreman, a man who had more than 30 years of experience in railroad grading, and one who had given thought and study to his work, and he had repeat-

edly had charge of scraper work. With his experience, and through continual watching, his scrapers moved with clock like precision, his men worked with a snap and vim, and small accidents and incidents were not allowed to interfere with the movement of the teams and men. Scraper loaders allowed to hold a pan wrong, means, not only the stalling of the team being loaded, but the delaying of teams following. Poor plowing can also delay the work, as can other incidents.

In the first example the foreman was not only of limited experience as a foreman, but totally inexperienced in scraper work. He thought his work consisted of standing on the side of the cut watching the loading crew, with the result that his gang nominally ran itself, and there were frequent delays from various causes. The teams moved at a snail's pace, and money was lost on the work. It is true that he was handicapped by being short of teams, and by other things, but by close attention to his work he could have bettered many conditions and cut down the cost of the work. With the damp, heavy material he could have had the ground plowed two or three times ahead of the scraper, so as to break it up as much as possible and thus have loaded the scrapers quicker and better. Each scraper could have thus carried a heaping load.

The plow team could have easily done this extra work, as in loosening only 90 cu. yds. per day they were bound to be idle at least 70 per cent of the time. This extra plowing would have also cut up the roots better, making easier loading for the scrapers. The teams were capable of making a greater distance than 10 miles per day, and it was clearly the foreman's fault that they did not do so.

This shows how easily it is for a foreman to shirk his work, and it also shows that a contractor is frequently at the mercy of his foreman. The lesson is also taught that experienced foremen capable of obtaining good work from their men and teams, are the ones to be hired, as their salaries, even if high, is but a small item of the cost of the work, and when efficient work is done the foreman cost is a less proportion of the total cost of the work than when indifferent work is done.

It is true that young men must be trained to assume charge of work as foremen, but this can be done by giving them positions of sub-foremen or assistant foremen, until they have gained some experience, and they should be impressed from the start of the importance of close study of all the work they do, not so much to follow what has been done by others, but to learn new ways and methods that will reduce the cost of the work in hand. When they are finally put in charge of work by themselves, it is necessary for the superintendent of the job to watch them continually, and to render them every assistance possible. This should not be done by al-

ways finding fault with them, but by advice and instruction, and reprimanding when it is imperative to do so.

We have given the cost of these two jobs not so much for the value of the cost data they contain, but rather to illustrate how work can cost much more than it should, and to show the need of good foremanship.

The Cost of Repairs to Locomotives and Cars.

During the 11 months from July 1, 1907, to June 1, 1908, the cost of repairing the locomotives in the service of the Isthmian Canal Commission, at work on the Panama Canal, was \$250,800.21. There were 280 locomotives in service, thus making the cost of repairs \$895.72 per locomotive, which would be \$81.45 per month or \$977.16 per year. On the isthmus work is carried on in one shift every day in the year, except Sundays and holidays.

These locomotives are standard gage and the majority of them have been bought since the U. S. Government has started the work on the canal, the rest being those left by the old French company and repaired by the Isthmian Canal Commission. Up to July 1, 1907, there had been spent for locomotives by the commission \$2,088,633.17, which would mean an average value for each of the 280 locomotives of about \$7,500. Thus the repairs for a year have been about 13 per cent of the cost, or about 1.1 per cent per month.

In building a new line for the Western Maryland R. R. in Maryland Mr. Mike Elinore used on this work at Big Pool, Md., 8 cars of the Lawson type. The material handled was a heavy clay and some gravel, with occasional boulders in it. The cars were loaded with a steam shovel. The average haul was 11 miles. The cars were worked for eight months on this job, and in that time handled 200,000 cu. yds. of material, making an average of 25,000 cu. yds. per car.

The Lawson car is of steel throughout, of standard gage and of the M. C. B. standard type. They have a capacity of 80,000 and 100,000 lbs. It is a side dump car, being operated by compressed air taken from the locomotive. The eight cars were valued at \$25,000 and before going onto the job were put in first class condition. The cost of repairs on these eight cars for the eight months that they were in use was only \$9.81. This put them in as good condition as when they were sent to the job, ordinary wear excepted. This would mean \$14.70 for repairs for the eight cars for a year, or about \$1.85 per car per year. This is a very low cost for repairs for cars used in excavation.

The output of coal in 1907 in the mines of the United Kingdom was 267,830,962 tons, a total of 940,618 persons are employed in the mines.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Fall Increaser, A Device for Increasing Turbine Efficiency.*

BY CLEMENS HERSHEL.†

Those who have studied the theory of, or have worked with, a Venturi Meter will not have failed to notice that "negative pressure," or suction, may be generated in the throat of the meter. Such negative pressure, amounting to a suction sufficient to hold suspended a water-column of 25.5 ft. in height, was observed during the making of the original Venturi Meter experiments, recorded in the Transactions of the American Society of Civil Engineers of 1887 and 1888. The East London Water Works Company habitually used the first 48-in. meter set up by them about 1897 to pump out the meter vault, by connecting the throat of the meter to the leakage accumulated in the vault. This gave me the idea in 1903, when told in Zurich, Switzerland, of the crude apparatus of M. Saugey of Geneva, in charge of the Chèvres Power House of the city of Geneva, that by the use of negative pressure a much better result could be achieved. Other occupations soon drove this idea from my mind, and it remained dormant and forgotten until 1907, when I read an account of the Saugey apparatus and its tests in the *Zeitschrift des Vereins Deutscher Ingenieure*. There followed a protracted series of sit-and-think: creative hours of mental work; a letter to a friend in Geneva saying that I could construct better than what they had before them; his reply saying that the city of Geneva had in March, 1907, offered prizes for a design of a power house to be built at La Plaine (Usine, No. 3); my determination to compete; the full invention of the Fall-Increaser; in October of that year an award to me of one of the prizes offered; the issue of United States Patent No. 873,435, Dec. 10, 1907; and the series of experiments on the Fall-Increaser now to be described.

The experiments were made at the Testing Flume of the Holyoke Water Power Co., Holyoke, Mass. This testing flume was built in 1881, principally as a means for measuring the amounts of water used by the various tenants of the Holyoke Water Power Co., although it was always contemplated that turbine tests for turbine builders and others should also be made (over 1,700 have been made to date), and that the flume should also be available for the making of other large scale hydraulic experiments. Thus the first two Venturi Meters made were tested in this flume, and a description of the flume may be found in

the account of the original Venturi Meter experiments, above cited. Having thus been created in this testing flume, it was very fitting that the Venturi Meter should in turn come back to the flume, and as a mere implement assist in the tests and the establishment of the Fall-Increaser, as will presently appear.

Now as to the Fall-Increaser; it is best illustrated by a brief description of its use as designed for a case in actual practice. The city of Geneva, Switzerland, which has long had in operation two municipal central power stations, utilizing the outflow of Lake Lemman (being a reservoir on the river Rhone), on March 1, 1907, announced its intention of building a third one, at the same time calling for plans and estimates, as was above stated.

This Power House No. 3, like Power House No. 2, was to have no dam appurtenant to it, to create a fall in the river, but only huge, balanced gates across that portion of the river which the power house itself did not occupy. The discharge of the river at the power house thus takes place either wholly through the wheels in use, or else partly through the wheels and the remainder underneath the gates, these being adjusted constantly so as to keep up the required head acting on the wheels. An unfortunate feature of such an arrangement of power plant is the necessity of lowering the head-water in times of great river flow (ordinarily called high water), so as to give the river slope enough, down to the power house, to carry off its flood flow without overtopping the gates and the power house floor, while at the same time the plant is subject to a rise in the river down-stream from the power house (the ordinary case of back-water), thus losing fall at both head-water and tail-water, a sort of "cutting the loaf at both ends." In this way the fall at La Plaine was expected to vary from some 43 ft. in times of "low water," down to only about 26 ft., when there is an abundance of water in the river. The first of these conditions obtained for about 100 days in an average year, while the second obtained for the other 265 days. It thus became of importance to utilize as much of this abundant flow of the river as possible, or else the output of power at this station would vary inordinately, and competitors were especially invited by the city in its *Programme de Concours* to endeavor to meet the point thus presented.

Ordinarily, or hitherto, many attempts have been made to construct water-power plants, subject to back-water, in manner to produce, in a certain measure, more power during times of back-water than

*Condensed from the Harvard Engineering Journal.

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the available fall would produce when using simple hydraulic turbines; by putting in complex arrangements of turbine wheels, frequently consisting of experimental designs or arrangements of such; with a moderate success in some cases, and a total failure in others.

But with the use of the Fall-Increaser no such complex design or arrangement of turbines is called for. Any simple, good construction of turbine will suffice; and by keeping the fall acting on the turbines a constant, the Fall-Increaser accomplishes much more with the simple turbines spoken of than could possibly be done by the use of any of the turbine arrangements which have been referred to, or such as have hitherto been used.

The power house design I sent in to meet these views, and the situation presented, is shown in Figure 1. The large circular wicket-gate, shown open in the drawing, is only left open at times of a

will cause the turbines to yield about 1.8 times the power they would naturally produce; on the well-known principle of the power of a turbine varying as the 3-2 power of the fall, its own gate-opening remaining constant; and that the construction expense involved, since the invention consists principally in leaving the proper shaped holes in the concrete foundation of the power house, is surprisingly small. It will frequently amount to not more than about \$4 per horsepower, all charges included; a fixed charge of about 24 cents per annum per horse-power. In return for this, many kilowatt hours will be produced annually, and at a time when they are most needed, thus saving at such times the use of auxiliary heat engines to meet both normal and peak loads.

To test my own reasoning in this matter, for there had been no time for this up to the date of mailing this design to Geneva (about Aug. 15, 1907), and only

ness. When in use this box was wholly under water, so that leakage could only consist of a leakage of water into the box. From various indications, it is believed that there was very little leakage during the final experiments. In some of the earlier ones when there was a vacuum of nearly 27 ft. of water-column in the box, the delights of working with a vacuum chamber made of spruce wood were experienced to the full, and up to the bursting in of the floor and sides of the box; but a reconstruction of the bracing, inside the box, soon made it tight and solid.

B is the 16-in. pipe bringing in the "operating water" to the "throat-piece" *C*.

Six different shapes of throat-piece were tested, and each of these was tested with some of the draft-holes closed up, so as to find, experimentally, the best shape of throat-piece, and proper area of draft-holes. In the apparatus shown, a change of $\frac{1}{2}$ in. in the diameter of one end of the throat-piece will make a difference of 3 per cent or more in the efficiency of the Fall-Increaser.

The apparatus is completed by the wooden cone *D*, forming a prolongation of the throat-piece.

If a turbine water wheel, or other water discharging apparatus is attached to such a vacuum box, and the operating water is allowed to flow through the pipe *B*, a vacuum or negative pressure may be generated inside the box, which will increase the discharge of the turbine or feed-water pipe, by increasing the head acting on it; and in case of a turbine, will increase the power of the turbine, as has been stated, by an amount proportional to $h^{3/2}$ when h is the original head acting on the turbine.

In the experiments under consideration, a 16-in. Venturi Meter measured the operating water; and a 12-in. meter measured the feed-water; and it was, naturally, of the greatest convenience to be able to know at every moment of time how much water was passing through each pipe; or, by means of the regulating gates on the 16-in. and the 12-in. pipe, to set these gates so as to discharge a desired quantity of water.

The head acting on the operating water was measured by a water-column, tapped into the flange and through the walls of the 16-in. pipe at *a*; while the vacuum produced was measured by a bent tube manometer tapped into the ceiling of the vacuum box, sucking up a column of colored water out of a pail, as shown at *b*. In some of the experiments, the water-column, tapped in at *a*, did not exist; and for such, the loss of head caused by the Venturi Meter (the 16-in. regulating gate in these experiments was left wide open), and by the 16-in. pipe, including its two bends, was taken as found for the same quantities of water passing the 16-in. pipe, in the experiments made after the water-

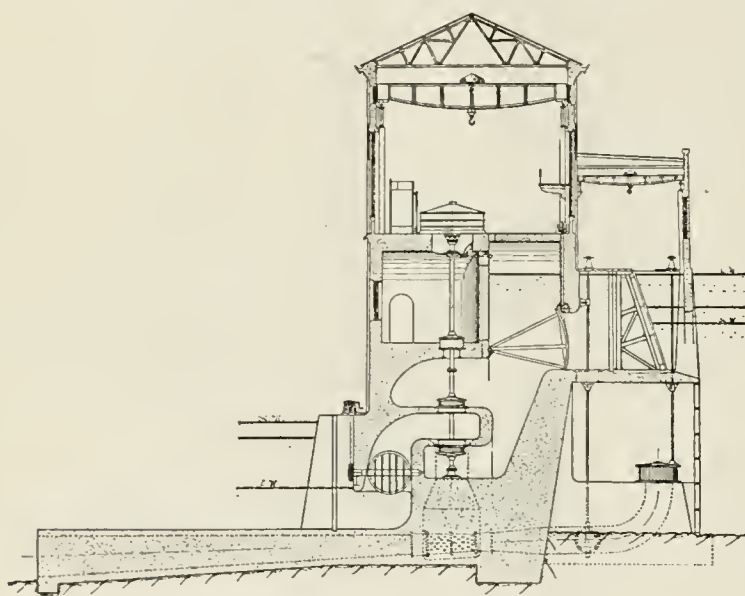


Fig. 1—Sketch of Power House Design.

low-water flow in the river, at which times the Fall-Increasers are not in use, and their operating gate, shown on the right, is shut off. There are two Fall-Increasers for each turbine unit of two turbines on one vertical shaft, and their discharge cones are made elliptical, with the major axis placed horizontally, so as to keep down the outside top of the concrete cones, used as an apron to receive the direct discharge of the two turbines through the large wicket-gate. When the two turbines discharge through the Fall-Increasers this large wicket-gate is shut.

The Fall-Increasers shown underneath the turbines, and operating at a time when the direct discharge of the turbines has been shut off, exhaust the turbine discharge from the vacuum box, and also produce a partial vacuum in this vacuum box, thus increasing the fall that would otherwise act upon the turbines.

I may say at once that the fall may thus readily be increased 50 per cent, which

7 weeks in which to make all the drawings and the report called for, I devised the experimental plant shown in Figure 2. This was set up in the Holyoke Testing Flume, already spoken of, and let me say here, that some of the most delightful hours I ever spent in my life, were thus passed in this cold and wet old testing flume; clad in workman's clothes; in the company of assistants, many of whom I had left in Holyoke in 1889, on resigning the position of Hydraulic Engineer to the company to take up certain duties in New York; all eagerly pursuing the workings of natural laws as they might be developed by the apparatus we were using.

A, in Figure 2, represents what we called the vacuum box, made of the peculiar *L* shape shown, so as to fit into the available space in the testing flume. Made of wood, with a double lining of the floor, ceiling and sides, and plenty of white lead in all the joints to ensure tight-

column had been tapped in at *a*. The vacuum, also, was measured in some of the experiments by a spring vacuum gauge, which was compared with a mercury column both before and after the experiments.

Table I gives the results of experiments on throat-piece *F*, while Table II

the turbine with the increaser = $Q'(h+h')$.

$$\text{Also } Q:Q' = \sqrt{h}:\sqrt{h+h'}, \text{ or } Q = \frac{Q'\sqrt{h}}{\sqrt{h+h'}}$$

Work gained by the use of the increaser.—

$$= Q'(h+h') - Qh.$$

$$= Q'(h+h') - \frac{Q'h\sqrt{h'}}{\sqrt{h+h'}} = (a)$$

And the efficiency of the increaser is this quantity, divided by the work employed to gain it; or

$$\text{Efficiency} = \frac{(a)}{\text{operating water} \times h}.$$

The fact clearly shown by Diagram I, that the efficiency of the Fall-Increaser is the same, for equal water-ratios and head-ratios, is a valuable one; enabling the normal efficiency to be maintained for all the varying discharges of the turbine.

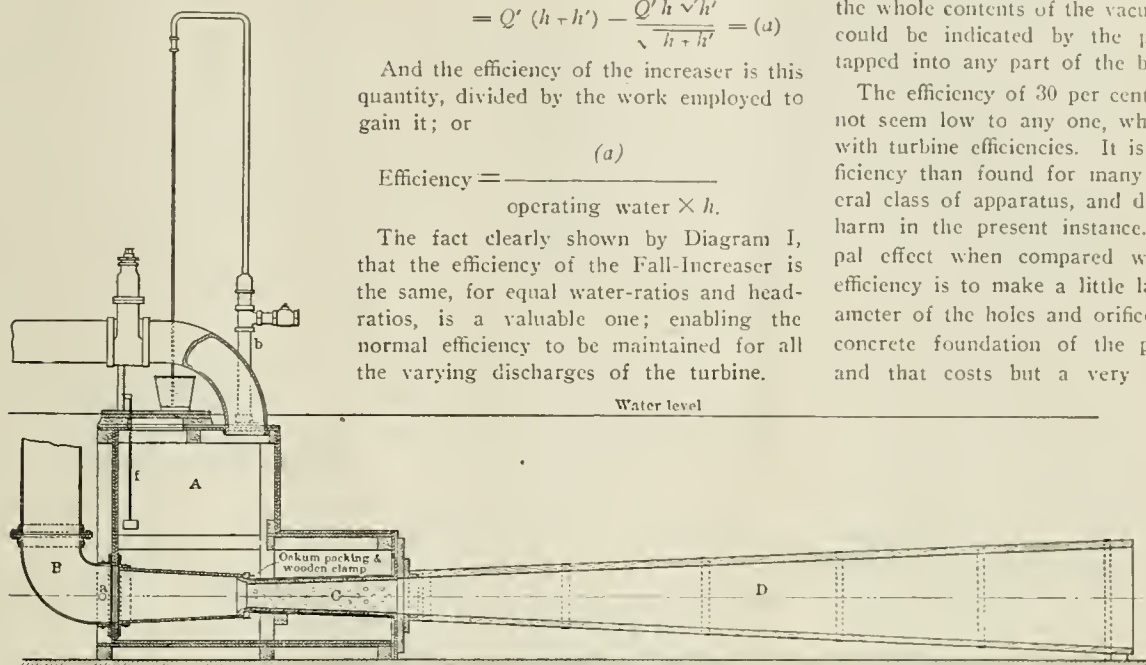


Fig. 2—Sketch Showing Experimental Plant.

gives the full-gate operating-water experiments on throat-piece *B*. As will be seen from Table I, and from its representation in Diagram I, the efficiency of the Fall-Increaser is the same for equal ratios

of $\frac{\text{water lifted}}{\text{operating water}}$ and of $\frac{\text{head gained}}{\text{operating head}}$;

called, respectively, the "water ratio" and the "head ratio." This having proved true in all the complete series of experiments, it authorizes the plotting of the diagram for throat-piece *B*, from the results alone of the full-gate operating-water experiments made with that throat-piece.

In an apparatus of this sort it does not palpably appear what is the true efficiency of the apparatus.

The Fall-Increaser comprises the vacuum box, no less than the throat-piece and its feed, and exhaust; and as such, causes increased discharge of the turbine, to which it is applied, as well as an increase of fall acting on the turbine as has already been noted.

Let h = operating head, on 16-in. pipe;
 h' = head gained; or vacuum.

Q' = water lifted = discharge of turbine under head $(h+h')$.

Q = discharge of turbine under head h .

The work done by the turbine without the increaser = Qh ; and the work done by

A rather startling feature of the experiments was shown by the action of a float; used to indicate the water level inside the vacuum box; see *f* in Figure 2. This float would be firmly pressed by flo-

There is not likely to be any scarcity of freshet water for operating the Fall-Increaser, so that no harm is done in this direction by a 30 per cent efficiency. In the case of the city of Geneva, a care-

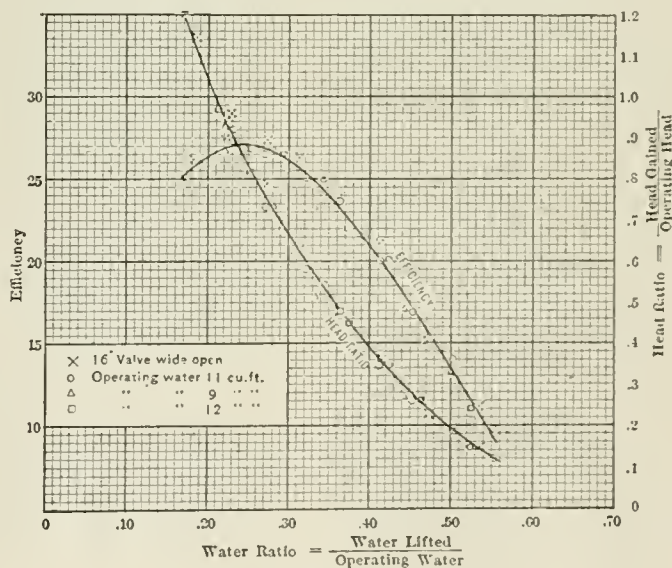


Diagram 1.

tation against the inside ceiling of the vacuum box, while the vacuum gauge indicated may be 14 feet of vacuum or negative pressure. In other words, though the vacuum box was full of water, there, nevertheless, was a partial vacuum of 14 feet of water column, pervading the whole

ful analysis of five years' daily record of river flow* showed that the normal power output of Usine No. 3 could have been maintained by the Fall-Increaser for the

*See Transactions of American Society of Civil Engineers, 1907, for a similar analysis of 20 years' flow of the Connecticut River.

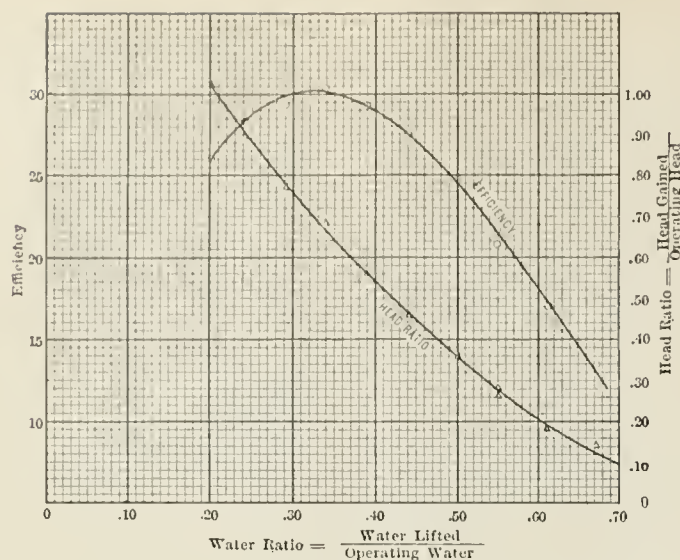


Diagram 2.

1,325 days of low fall occurring during those five years.

The maximum efficiency of throat-piece *B* corresponds to a water-ratio of 0.33, while in throat-piece *F* it corresponds to a water-ratio of only 0.25. That is to say, in the case of throat-piece *B*, the operating water must be three times the discharge of the turbine, and in the case of throat *F*, it must be four times the discharge of the turbine, to attain a maximum of efficiency, and a high head-ratio. In practice it will generally be found best to compromise in this matter, and be content with less than the greatest possible head-ratio. Thus, in the case of throat *B*, it is perfectly expedient to make the head-ratio, say 0.50, with a water-ratio of 0.42 and an efficiency of 0.28. See Diagram 11.

It was in this inter-relation of head-ratio and water-ratio that the several throat-pieces tested, differed most. So much so, as to render the use of some of them impracticable for purposes of a Fall-Increaser.

The Fall-Increaser is not an ejector, and experiments made with an ejector form of throat-piece, and a $5\frac{1}{2}$ -in. nozzle endeavoring to operate it, gave so poor results that there was no encouragement to continue along those lines.

Nor does it seem to me that the forms of formulae found in the books and learned transactions for computing the work of ejectors, based on the assumption of an impact of the nozzle stream upon the water within the throat-piece, are based upon a proper assumption to produce a correct formula for representing ejector action. To my mind an ejector is only another form of negative pressure apparatus, in which suction causes the water to enter the throat-piece through a ring-shaped orifice situated all around the nozzle, rather than through holes fashioned in the throat-piece itself, and distributed over its whole outside surface, as in the Fall-Increaser.

It is with great pleasure that I make acknowledgment here of the aid given me

both in the making and in the computing of these experiments by Mr. A. F. Sickman, my former assistant at Holyoke, and

TABLE I—EXPERIMENTS ON THROAT PIECE "F" WITH ALL HOLES OPEN.

Number of experiment	Time	Height of water in		Operating Head Col. 4 — Col. 5	Operating Water.	Water Lifted	Head gained by use of Fall-Increaser	Ht. of Water in vacuum-box by float	Air-valve	Gauge on 12 in. valve	Water-ratio = Col. 8 Col. 7	Head-ratio = Col. 9 Col. 6	Quantity (a)	Efficiency = Col. 15 Col. 6 x Col. 7	
		Forebay	16 in. pipe next the vacuum-box												Tail-race
		Feet			Cubic Feet per second			Feet						%	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	9.05	99.23	94.89	81.96	12.93	11.39	6.00	1.93	Full	Shut	56.1	0.53	0.15	16.62	11.3
2	9.10	99.25	94.70	81.95	12.75	11.63	5.51	2.88	—	—	52.8	.47	.23	22.58	15.2
3	9.13	99.29	94.37	81.95	12.42	12.06	5.00	4.52	—	—	47.2	.41	.36	31.64	21.1
4	9.16	99.35	94.11	81.95	12.16	12.39	4.50	5.87	—	—	43.0	.36	.48	36.20	24.0
5	9.20	99.41	93.82	81.95	11.87	12.84	4.00	7.50	—	—	39.0	.31	.63	40.25	26.4
6	9.23	99.55	93.53	81.94	11.59	13.20	3.50	9.10	—	—	35.0	.27	.79	42.10	27.5
7	9.27	99.67	93.26	81.94	11.32	13.60	3.00	10.83	—	—	31.5	.22	.96	42.22	27.4
8	9.30	99.73	92.97	81.93	11.04	13.97	2.50	12.58	—	—	28.2	.18	1.14	40.20	26.1
9	9.34	99.72	88.96	81.81	7.15	11.01	2.50	6.58	—	—	29.1	.23	.92	21.42	27.2
10	9.37	99.64	89.73	81.81	7.92	11.01	3.00	5.80	—	—	33.1	.27	.73	23.11	26.5
11	9.41	99.62	90.43	81.85	8.58	11.00	3.50	5.00	—	—	36.7	.32	.58	23.62	25.0
12	9.44	99.60	91.36	81.85	9.50	11.05	4.00	4.53	—	—	40.4	.36	.48	24.91	23.7
13	9.48	99.59	91.74	81.83	9.86	10.95	4.50	3.45	—	—	44.3	.41	.35	21.72	20.1
14	9.53	99.57	92.81	81.99	10.91	11.00	5.00	2.86	—	—	48.9	.45	.26	20.33	16.9
15	9.56	99.52	93.55	81.93	11.62	11.03	5.50	2.31	—	—	52.6	.50	.20	18.13	14.1
16	9.59	99.47	94.19	81.94	12.25	10.98	6.00	1.50	—	—	57.1	.55	.12	13.16	9.8
17	10.05	99.50	84.31	81.80	7.51	9.91	4.50	1.40	—	—	46.0	.50	.19	9.02	13.3
18	10.08	99.49	88.68	81.79	6.89	8.99	4.00	1.85	—	—	42.3	.44	.27	10.27	17.1
19	10.11	99.47	88.08	81.77	6.31	8.97	3.50	2.52	—	—	38.2	.39	.40	12.24	23.5
20	10.14	99.48	87.65	81.75	5.90	9.00	3.00	3.02	—	—	35.0	.33	.51	12.38	23.3
21	10.18	99.50	86.85	81.72	5.13	8.99	2.50	3.72	—	—	30.3	.38	.73	12.36	26.8
22	10.22	99.52	86.26	81.71	4.55	8.98	2.00	4.22	—	—	26.6	.22	.93	10.99	26.8
23	10.27	99.52	89.33	81.83	7.50	12.05	2.00	8.97	—	—	25.5	.17	1.20	22.82	25.2
24	10.30	99.54	90.25	81.85	8.40	12.00	2.50	8.17	—	—	29.3	.21	.97	26.46	26.3
25	10.33	99.56	90.94	81.86	9.08	11.99	3.00	7.43	—	—	32.4	.25	.82	29.34	26.9
26	10.36	99.57	91.80	81.88	9.92	11.99	3.50	6.75	—	—	36.0	.29	.68	31.53	26.5
27	10.40	99.60	92.55	81.90	10.65	11.91	4.00	5.83	—	—	39.6	.34	.55	31.71	25.0
28	10.44	99.59	93.85	81.94	11.91	12.11	4.50	5.30	—	—	43.8	.37	.45	32.89	22.1
29	10.48	99.58	94.32	81.95	12.37	11.98	5.00	4.28	—	—	47.5	.42	.35	29.89	20.2
30	10.51	99.57	94.83	81.96	12.87	11.92	5.50	3.37	—	—	51.4	.46	.26	26.26	17.1
31	10.55	99.57	95.22	81.96	13.26	11.48	6.00	1.93	—	—	56.8	.52	.15	16.94	11.1
32	10.59	99.56	95.27	81.95	13.32	11.32	6.00	2.30	79.65	open	59.4				
33	11.03	99.57	95.08	81.94	13.14	11.61	5.50	3.36	78.58	—	55.6				
34	11.06	99.58	94.92	81.93	12.99	11.81	5.00	4.13	77.80	—	52.0				
35	11.09	99.60	94.82	81.91	12.91	11.89	4.50	4.33	77.58	—	48.1				
36	11.13	99.62	94.86	81.88	12.98	11.92	4.00	4.38	77.50	—	43.9				

TABLE II—EXPERIMENTS ON THROAT PIECE "B" WITH ALL HOLES OPEN.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	9.07	99.66	95.88	81.92	13.96	10.83	6.00	3.70	Full	Shut	.55	.27	31.57	20.9	
2	9.10	99.65	96.10	81.93	14.17	10.58	6.50	2.73	—	—	.61	.19	25.59	17.1	
3	9.14	99.67	96.29	81.94	14.35	10.40	6.99	2.00	—	—	.67	.14	20.20	13.5	
4	9.18	99.68	95.88	81.93	13.95	10.84	6.00	3.88	—	—	.55	.28	33.00	21.8	
5	9.22	99.68	95.67	81.92	13.75	11.08	5.49	4.95	—	—	.50	.36	37.84	24.8	
6	9.26	99.67	95.37	81.92	13.45	11.38	5.00	6.13	—	—	.44	.46	42.06	27.5	
7	9.30	99.68	95.13	81.91	13.22	11.64	4.50	7.97	—	—	.39	.56	45.08	29.3	
8	9.33	99.67	94.86	81.89	12.97	11.91	4.00	8.78	—	—	.34	.68	46.92	30.4	
9	9.36	99.66	94.66	81.89	12.77	12.12	3.50	9.85	—	—	.29	.77	45.58	29.4	
10	9.39	99.64	94.39	81.88	12.51	12.38	3.00	11.25	—	—	.24	.90	44.00	28.4	
11	9.42	99.61	94.16	81.87	12.29	12.60	2.50	12.52	—	—	.20	1.02	40.37	26.1	

successor in the work and duties of Hydraulic Engineer of the Holyoke Water Power Company; also to the East Jersey Pipe Company of Paterson, N. J., Thos. H. Gillespie, Vice-President, for the gift of the 16-in. pipe; to the Society for Promoting Useful Manufactures, John H. Cook, Engineer, of Paterson, N. J., for the loan of a 16-in. valve; to the Water Department of the city of Holyoke, James Tighe, Engineer, for the loan of 16-in. and 12-in. pipe, and a 12-in. valve; to the Builders Iron Foundry of Providence, R. I., for the loan of a 16-in. and a 12-in. Venturi Meter, and of two Manometers; and last, but not least, to the Holyoke Water Power Company, for especial help and favors shown me in aid of the making of these experiments.

During the past four years contracts have been placed for 185,150 bbls. of cement for use on the Isthmian Canal work, and all but about two thousand barrels of this was delivered in barrels.

LETTERS TO THE EDITORS.

Standard Sizes for Periodicals.

SIRS: The writer has noted with interest your comment upon the standard sizes of periodicals and catalogues in your issue of July 1, 1908. This matter is of special importance in these days of high rental value per square foot of office space, and especially since the advent of the vertical filing system.

The writer believes that in view of the great convenience of the vertical letter file which takes a sheet $8\frac{1}{2} \times 11$ ins. in size, that the technical periodicals will some day find it to their advantage to reduce their page from the present 9×12 standard to the standard letter size of $8\frac{1}{2} \times 11$.

You may be interested to see how in one filing system the pages of engineering-contracting are trimmed to adapt them to this system of filing and reference. The sheet attached shows the trimming that is necessary, and also the standard Tengwall punching which enables a large number of sheets upon the same general subject to be bound together in loose leaf folders.

Very Truly Yours,

EDW. N. LAKE.

Division Engineer.

Board of Supervising Engineers Chicago
Traction, July 10, 1908.

(The trimmed sheet of Engineering-Contracting takes in the full inside margin, the running head at top, about $\frac{3}{4}$ in. of the bottom margin, and about $\frac{1}{4}$ in. of the outside margin.—Editors.)

A Suggestion for Furnishing Schedules to Subcontractors for Bidding Purposes.

SIRS—I wish to express a thought that has occurred to me from time to time. The thought is this: Is it not possible for some thoroughly reliable concern to make a specialty of furnishing itemized quantities and a copy of specifications to prospective bidders, who may be out of town and unable, for obvious reasons, to either travel to the office of architect or engineer to obtain plans, etc.? It appears to me it can be done for a reasonable charge for service rendered.

I may illustrate my present position in this way. I am invited to furnish estimates on lathing and plastering a large institution at Troy, N. Y., and, as it happens in this case, one of the large contractors of New York and Philadelphia desires my proposition, but I am apparently handicapped by being a specialist and subcontractor. The architect has kindly furnished me with a list of bidders and regrets he cannot furnish me with a set of plans; they are all out. Sixteen firms are bidding, nine in New York but none in this section, and my bid must be in New York the morning of the 10th. This has happened time and again in estimating for postoffices and public buildings. We have

local estimators, but I have never seen the announcement on the lines as stated above.

Very truly yours,

ANDREW TAYLOR, JR.,

Contractor.

Buffalo, N. Y., July 3

[It would seem from our subscriber's letter that general contractors make a vast mistake in not furnishing to sub-contractors blue prints and schedules of work, upon which they can submit bids. The most that the majority of them do, is to allow sub-contractors to use the blue prints to take off the information they may need. We know of one exception to this rule, in the person of a prominent contractor of New York, who has his own office force take off all quantities of work of each character on buildings, making up a schedule, which is submitted to the sub-contractors to name a price upon. This practice is to be commended. If general contractors would pursue this method in all bidding, the difficulty that Mr. Taylor complains of would be overcome.—Editors.]

Standard Sizes for Drawings.

SIRS—Mr. Low's criticism of the 9×12 -in. size and his reason for advocating $8\frac{1}{2} \times 10\frac{1}{2}$ -in. size for shop drawings reminds me of one of Chordal's letters in which he tells of a young draftsman who prepared several foolscap sheets of written description to accompany a small drawing he had made.

A drawing should be so made and dimensioned that the workman without further instruction can make the piece required and cannot by any possibility make anything else. This can be done and that it is not done more often is due either to a lack of knowledge of shop operations on the part of the draftsman or to indifference or carelessness.

The first question a draftsman should ask himself when making a shop drawing is, How will this piece be made? What dimensions will be required by the patternmaker and machinist? If a casting, how will it be molded? What machines will be used to finish it and how will it be held in them? He will often find that a slight modification in his design will very materially reduce the cost both in foundry and machine shop.

If more of our young men who aspire to positions of responsibility in the mechanical world and adopt the drafting board as a stepping stone thereto, would put in two or three years in getting all around experience in the shop they would find the time well spent.

Aside from the fact that it should not be necessary to send out written descriptions with drawings, it will be found that 9×12 -in. and multiples and subdivisions thereof is more economical as the standard widths of detail paper and tracing cloth cut into these sizes without waste whereas the waste in cutting to say $8\frac{1}{2} \times 10\frac{1}{2}$ in.

will amount to considerable in the course of a year.

In his original letter the writer had in mind mechanical drawings, whereas Mr. Low naturally comes more in contact with civil engineering drawings, but we cannot see that this materially alters the case or why a standard which has proven itself convenient and economical in the one case should not be equally desirable in the other; however, as almost any standard is better than the present haphazard sizes for drawings, catalogues and specifications the writer will cordially welcome the universal adoption of any reasonable sizes.

Yours very truly,

W. M. DOLLAR.

Mem. Am. Soc. M. E.

Consulting Engineer.

Buffalo, N. Y., July 14, 1908.

The Cost of Sand for a Filter, Showing the Cost of Washing, and the Per Cent Washed Away.

The following data is extracted from the Journal of the New England Water Works Association from a paper by Messrs. M. F. Collins, Morris Knowles and Arthur D. Marble on the filters of Lawrence, Mass. The paper ends with a description of a new filter recently built. Regarding the 5,000 cu. yds. of sand used in the filter the paper has the following to say:

"A detail study of the cost of the filter sand shows that two-thirds of the sand was washed and that the remaining third passed examination after screening at the bank. The sand from the general run of the bank gave from $2\frac{1}{2}$ to 4 per cent finer than 0.13 millimeter, which was the minimum size allowed. After washing there still remained from $\frac{1}{2}$ to $1\frac{1}{2}$ per cent of this fine material. It was thus estimated that about 3 per cent was lost in washing, which checks very well with the count of the number of loads hauled from the bank.

"No accurate data were kept as to the cost of the sand, but some general notes taken may be helpful. It was estimated that the sand was worth 10 cts. a cu. yd. at the bank and the cost of screening, together with the cost of hauling, added 40 cts. In addition to this there were $6\frac{1}{2}$ cts. more for general expenses, including spreading in the filter, making the total cost of the unwashed sand $56\frac{1}{2}$ cts. per cu. yd., delivered in place at the filter. In the same way it was estimated that the cost of the washed sand was $76\frac{1}{2}$ cts. delivered in place at the filter. (The cost of washing was thus 20 cts. per cu. yd.—Editors.) When the shrinkage in the water settlement is taken into account, which amounted to $4\frac{1}{2}$ per cent, or a depth of 0.2 ft., these sums became respectively 59 cts. and 80 cts. The price bid was 60 cts. The cost of the filter sand exhibits in a typical way something about how near the contractor estimated what his work would cost him, and it is probable that upon many of the

other items of the contract he made no greater amount of money. The final return of the quantity of filter sand, after settling, was within 9 yards of the estimated quantity.

In making tests for the sand for the filter it was done by placing 10 cu. ins. of sand, closely measured in another 10, into a conical receptacle, having a screen at the base of 14 meshes to the inch. Testing receptacle was 3 ins. in diameter at the top, 2 ins. in diameter at the bottom and 8 ins. high. A coarse screen, of 6 meshes to 1 in., was placed on top of the sand, water was then filled in the receptacle and the time of passage through the sand was noted. Acceptable filter sand allowed the water to pass through in from one minute to one minute and thirty seconds.

The total cost of the filter plant was \$54,331.48, the amount paid to the contractor being \$49,446.11, the difference, \$4,885.37, being the cost of printing and issuing of bonds and the cost of engineering expenses. This amounted to 9 per cent of the total cost.

Blown Joints in Water Pipes.

Mr. S. A. Gailey in a paper before the American Water Works Association gives the following experiences with blown joints:

"A line of water pipe passes under the railroad tracks in our distributing system, and the joint comes directly under one rail. This joint was partially blown out several times and had been recorked. We were unable to keep it tight, and finally were compelled to take it out and place a full length under the track so as to bring the joints of pipe between the tracks, or what is generally termed in railroad language, as the 'fire foot' between each set of tracks. After doing this we experienced no further trouble from this particular joint, after some four years of trial.

"In a similar case where we had a leaking joint under the rail, after trying many plans to repair it, we finally resorted to the use of lead wool and after making the repairs we have found it to remain in good shape for about one year, indicating that a blown joint can be more successfully repaired with lead wool than with cold lead corked in."

During the fiscal year ending June 30, 1908, 1,506 vessels, of 588,627 gross tons, were built and numbered in the United States, of which 75 steel steamers, of 304,379 gross tons, were built on the Great Lakes.

The building of the projected \$12,000,000 trunk sewer from Paterson, N. J., to Newark Bay to prevent the pollution of the Passaic River, seems to be assured, as representatives of ten of the municipalities affected have voted in favor of the work.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0819. **Well Drilling Machinery.** The Crown Drilling Machine Co., Akron, O.

This 63-page pamphlet describes the regular sizes of drilling machines ranging from 50 to 600 ft. made by the company named. The descriptive matter is notably complete and is made clear by line drawings. Full instructions are given for setting up and operating each size of machine, and schedules of complete outfits are given. In addition, a full line of drilling and fishing tools, jars, bits, spuds and engines and boilers are illustrated with tables of dimensions, etc.

No. 0820. **Center Dump Buckets.** The Inley Iron Works, Indianapolis, Ind.

The center dump concrete bucket described in this 8-page pamphlet is worthy of being known by all concrete workers. It is so designed that the rate of discharge can be positively controlled and that it can be discharged into narrow wall forms or in thin layers on centers without shock or back kick. Seven sizes from ½ cu. yd. to 3 cu. yds. are listed, with dimensions, weights and prices.

No. 0821. **Ferro-Lithic Plates.** The Berger Mfg. Co., Canton, O.

Ferro-lithic plates are steel plates with special dove-tail corrugations which are plastered on both sides with cement mortar to form slabs for roofs, floors, sidings, etc. The plates are made both flat and curved. Their construction is described and full directions are given for constructing ferro-lithic roofs, floors, etc., with the details of all connections illustrated. This is a descriptive catalog of unusual merit.

No. 0822. **Manual of Adjustments.** Iszard-Warren Co., Inc., Philadelphia, Pa.

This neatly printed vest pocket size pamphlet gives full directions for making all ordinary field adjustments of transit and level. It accompanies the company's 230-page general catalog of engineering instruments and draftsmen's tools and supplies. This company makes the well known Sterling transits and levels.

No. 0823. **Concrete Steel Floor Construction.** Leiber Hermann, 11 Broadway, New York.

This 5-page pamphlet presents the claims of the Hermann concrete steel floor. The system, it is claimed, effects a saving of from 4 to 12 cts. per square foot of floor surface over any other now in use. It is a panel construction, i. e., it consists of a flat slab supported by columns and beams so that the ceiling is divided by the beams into square or rectangular panels. The slab is composed of concrete reinforced by two independent layers of bars placed at the top and at the bottom thereof; the bars in the bottom layer run in two directions parallel to the beams of the panel, and the bars in the top layer are placed across the beams and over the columns; the bars in the top layer are preferably wired into units in advance and the units are dropped into place immediately after the concrete is cast.

No. 0824. **Victor Dump Wagons.** F. H. Hieber Wagon Mfg. Co., Pittsburg, Pa.

This 8-page pamphlet describes in detail the construction and operation of the Victor dumping device used on the bottom dumping wagons made by the above company. The device is simple and interesting and is well worth attention by wagon users.

No. 0825. **Asbestos Shingles.** Keasbey & Mattison Co., Ambler, Pa.

This 4-page pamphlet contains an article by Mr. Charles H. Stringer on the advantages and merits of asbestos shingles.

No. 0826. **Buckets and Cars.** The Union Iron Works, Hoboken, N. J.

This company is well known as manufacturers of apparatus for handling, hoisting, loading, unloading and conveying materials, industrial railway truck and cars, forgings, casting and steel sheet and plate work. This 56-page pamphlet catalogs these various apparatus and articles, giving prices, dimensions, capacities, etc.

Personals.

Mr. J. G. Gwyn, heretofore Assistant Chief Engineer of the Denver & Rio Grande R. R., has been appointed Chief Engineer, with headquarters at Denver, Colo.

Mr. F. F. Prendergast, Assistant Engineer on the Shoshone Project, after four years' work in the U. S. Reclamation Service, has resigned to engage in private practice.

Messrs. Adrian J. Yawger, George M. Chandler and Joseph Whitaker have organized the Yawger Co., of Indianapolis, Ind., and will engage in the construction of railroads, highways, etc.

Mr. D. H. Winslow, Resident Engineer for the Massachusetts Highway Commission, has been certified by the Civil Service Commission for the position of Superintendent of Road Construction for United States Government.

Mr. J. B. Bralnard, Assistant Engineer U. S. Reclamation Service, has left the Yuma Project on an extended leave of absence, and Mr. L. M. Lawson, Assistant Engineer, has been recalled to duty at Yuma, after an absence of about six months.

Michael Maggini, formerly a member of the engineer corps of the Interurban Railroad Co., of San Jose, Cal., has accepted a position with the engineering department of the Southern Pacific Co., and will be engaged on surveys for a railroad line through the Mojave Desert.

The Indiana Sanitary and Water Supply Association has been formed with the following officers: President, H. E. Barnard, State Pure Food Commissioner; first vice-president, Dow R. Gwyn, Terre Haute; secretary, Frank Jordan, Indianapolis; treasurer, Geo. A. Fletcher, Brazil.

Messrs. C. W. Brooks, of Houston, Tex., and P. M. Gordon, formerly of Detroit, Mich., have organized the Brooks-Gordon Construction Co., and will engage in a general contracting business, making a specialty of concrete construction. The officers of the company are in the Stewart Building, Houston, Tex.

Mr. E. F. Tabor, of the U. S. Reclamation Service, formerly employed on the Shoshone Project, has been designated as project engineer in charge of the Flathead Project, with headquarters at St. Ignatius, Mont. The engineering force includes A. J. Fisk, Jr., and F. Towles, assistant engineers, both transferred from the Sun River Project, and C. E. Hewitt, assistant engineer, recalled from furlough.

Mr. W. L. Abbott has been elected chairman and Mr. A. Bemont secretary of a joint committee formed at Chicago, Ill., for the purpose of combating the smoke nuisance. Mr. Abbott represents the Western Society of Engineers and Mr. Bemont is a consulting engineer. Mr. Paul Bird, on behalf of the city, and Mr. Carl Scholz, of the Illinois Coal Operators' Association, are the other members of the committee.

The following transfers in the U. S. Reclamation Service are announced in the July Reclamation Record: Mr. John T. Burke, Engineer, from the Yuma Project, Ariz., to the Sunnyside Project, Wash., to take charge of construction work. Mr. Joseph Wright, Engineer, from the Shoshone Project, Wyo., to the Milk River Project, Mont. Mr. J. E. Bell, Assistant Engineer, from the Sun River Project, Mont., to the Shoshone Dam, Shoshone Project, Wyo.

Mr. Murdoch Campbell has been appointed Commissioner of Buildings of Chicago, Ill. Mr. Campbell is the head of the Murdoch Campbell Co., building contractors, and has constructed buildings in many parts of the country, among them being eight Chicago world's fair buildings, the New London, Conn., postoffice, four New Orleans business blocks, and Tulane University buildings; Baltimore, Md., manufacturing plants; twelve Chicago skyscrapers, and eight residences.

Messrs. James N. Hazlehurst and C. L. B. Anderson, have become associated under the firm name of Hazlehurst & Anderson and will engage in Consulting Municipal Engineering practice with general offices in the Candler building, Atlanta, Ga. Mr. Hazlehurst has done a large amount of professional work throughout the South and is a frequent contributor to the various engineering magazines. He is the author of a standard reference book entitled "Towers and Tanks for Water Works," now in its third edition. Mr. Anderson is a graduate of the Massachusetts Institute of Technology and was for some time connected with the engineering faculty of Cornell University. He has made a specialty of municipal work, being actively connected with work along these lines in New England, New York and Pennsylvania.

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Certificated Engineers in Louisiana.

The state of Louisiana has passed a law limiting the practice of civil engineering to persons authorized by certificate from a state board of engineering examiners. This, we believe, is the first legislation of the kind to be enacted in the United States. As to the value in general of such legislation engineers will doubtless be divided in opinion. Personally, we must express little faith in its efficiency. No one doubts

that abuses and evils result from the present conditions which permit any one who has the inclination to dub himself civil engineer and to practice his "profession." Will legislation making engineering a close profession remedy the trouble? We doubt it. We doubt still more whether the new Louisiana law will command much respect even from those engineers who hold that some sort of legislation is desirable. We may quote here in proof only two sections of the law. They are:

Sec. 2. Be it further enacted, etc., that at the promulgation of this act, any person, before entering upon the practice of civil engineering or surveying, shall present to the board of engineering examiners, as hereinafter constituted, a diploma from an engineering college or school of good standing: said standing to be determined by the board, or shall pass a satisfactory examination before the board upon the following, to wit:

For Surveying—Geometry, trigonometry, land surveying, practical use of instruments.

For Civil Engineering.—Same as surveying, in addition thereto natural philosophy or physics.

The person shall also satisfy the board that he is 21 years of age, of good moral character, and possesses at least a fair primary education. If said diploma or examination are satisfactory to the board they shall issue to such person a certificate in accordance with the facts.

Sec. 5. Be it further enacted, etc., that all persons practicing civil engineering or surveying in the state of Louisiana before the passage of this act, shall within ninety days after its promulgation, register as such practitioners with the clerk of the district court of the parish within which they reside and upon the appointment of the board of engineering examiners, shall notify the said board of such registration.

It is plain that the new law will not free the state of its present plague, whatever that may amount to, of engineer fakirs. These will remain until Providence and their own sweet wills remove them from the state. The most the law can do will be to make certain that from now on the ranks of the undesirables are not increased. What does it promise in this respect? Very little it seems to us. An examination in geometry, trigonometry, etc., will not deter the scamp though it may the fool, and by the same token the man who can pass this examination is not necessarily competent to practice civil engineering.

Tests of Large Flat Beams of Reinforced Concrete.

A large amount of space in this issue is devoted to a description of tests made early this spring on concrete slabs or flat beams of unusual size. These tests are interesting in several respects. The beams tested, we believe, are the largest ever test-

ed at least with the same care to record the results in a scientific manner. They are also tests of beams built for and being used in actual construction.

Two of the prominent railways which are now elevating their tracks within the city limits of Chicago, viz., the Chicago, Burlington & Quincy and the Illinois Central railways, have adopted for viaduct construction at street crossings, a heavy reinforced concrete slab floor carried on columns and abutments. The floor or deck slabs are being cast separately, allowed to harden and then set in place in the supports with grouted joints. In our issue of Dec. 4, 1907, we described the method adopted by the Chicago, Burlington & Quincy R. R. for casting these large slabs and also presented some estimates of the cost of the work.

In the article to which we give space in this issue there are no methods and costs, but there is a very interesting record of tests of such large castings. Two principal facts are brought out by these tests. The first is that these immense flat beams as they were built show ample strength for the heavy work which they will be called upon to perform. From the point of view of the railway company for which the tests were made this result may perhaps be considered the all important one. To the student of reinforced concrete, however, there is an additional interesting fact brought out. It is that a beam 25 ft. long x 6¼ ft. x 2 ft. 10 ins. in section, behaves under bending test altogether similarly to the test beams of smaller and more usual cross-section that have been repeatedly tested in laboratory work.

These conclusions may be, we think, accepted with considerable confidence. The description of the methods bears evidence that the tests were conducted with care, and in addition the reputation and great experience of Professor Talbot are a guarantee which few engineers will fear to accept. In conclusion it is of importance to note the following practical point made by Professor Talbot in respect to the method of reinforcing these large flat beams. He says:

"The tests show the effectiveness of stirrups and of the method used in bending up bars at the end in resisting diagonal tension. As diagonal tension weakness is particularly undesirable, because of possibility of sudden failure and of injury with repeated application of the load and because of the difficulty of detecting incipient failures when the sides of the beam are not available for inspection, ample safety against these stresses is important. Failures by tension of the steel and by compression of the concrete give warnings through abnormal deflections and in other ways and are less likely to lead to serious results."

The city of Philadelphia, Pa., now has 16 bridges under construction, the total estimated cost being \$1,100,000.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

A Test of Reinforced Concrete Beams, 25 ft. Long, 6 1-4 ft. Wide and 2 ft. 10 ins. Thick.

BY ARTHUR N. TALBOT.*

The test here described will be of interest to engineers because the reinforced concrete beams were chosen almost at random from a large number of beams made up for use in a railroad structure and thus may be considered to be representative of actual conditions of construction, and because the tests give a comparison of the efficacy of two methods of placing the reinforcement to resist diagonal tension or so called shear failures. The beams were perhaps the largest reinforced concrete beams yet tested, and the testing apparatus used and the method of making the test involved some novel features. The beams were tested in the yards of the Illinois Central R. R. at 27th St., Chicago, close to the point where they were made. The beams were in the form of slabs 25 ft. long, 6 ft. 3 ins. wide, and 34 ins. deep at the middle, and weighed about 33 tons apiece. They were built for use in the floors over the subways of the Grand Crossing (Chicago) track elevation work now in progress of construction. The slabs span the distance from the curb to the center of the street pavement, making a floor over the street upon which the ballast is spread and the track laid for the eight track railway. The tests were undertaken through the co-operation of the Engineering Experiment Station of the University of Illinois and the Illinois Central Railroad to determine the properties of large beams made under practical conditions. As this is one of the largest and most important pieces of construction of the kind yet made, it seemed desirable to make tests of the slabs before putting the structure into service.

The slabs were built by the Illinois Central R. R. Co.'s force. The concrete was composed of 1 part cement, 2 parts sand, and 5 parts unscreened limestone. The concrete was machine mixed and was made so that little or no tamping was required. Owl portland cement was used. Tests of the cement gave a tensile strength of 822 lbs. per sq. in. for the 7-day neat test; 95.2 per cent passed the No. 100 sieve. The longitudinal reinforcement was 1-in. corrugated bars. Tests made by Robert W. Hunt & Co. on bars selected from those used on the work showed an elastic limit

of 52,000 lbs. per sq. in. Twenty-nine of the 1-in. bars were used in the width of 6 ft. 3 ins., the spacing being made $2\frac{1}{2}$ ins. center to center; and as the distance from top of slab to center of bars at the middle of the beam length was $30\frac{1}{2}$ ins. the reinforcement was about 1.25 per cent. Two forms of bending up the bars at the ends were used. In No. 70, which was the last slab made in this way, the bars were bent up at an angle of about 45° rather close to the end, the bend for one-fourth of them starting at about 2 ft. from the end, for another fourth at 3 ft., for another fourth at 4 ft., while the remaining bars were straight

six 1-in. bars, while transversely across the bottom longitudinal reinforcement were 21 $\frac{1}{2}$ -in. bars. At the middle of the width of the slab and at 2 ft. 6 ins. from either end heavy steel stirrups were inserted; these were used to fasten the lifting device to when the slabs were lifted and moved. The slabs tested were made Oct. 7 and 8, 1907. No. 70 were tested April 15 and No. 72 April 28, 1908. In the meantime they were left just where made and were exposed to the weather. Although they were over six months old, the setting of the concrete during the winter weather must have been slow, and the conditions would be less favorable than is usual for 90-day test beams.

The tests were made as follows: One slab was placed above another (the lower one having been turned upside down) with a bearing between them at their ends. Two yokes were placed at the one-third points of the span length, and four hydraulic jacks acting on the yokes were operated to force the slabs together. The diagram (Fig. 1) and the photographs will assist in understanding the method of making the

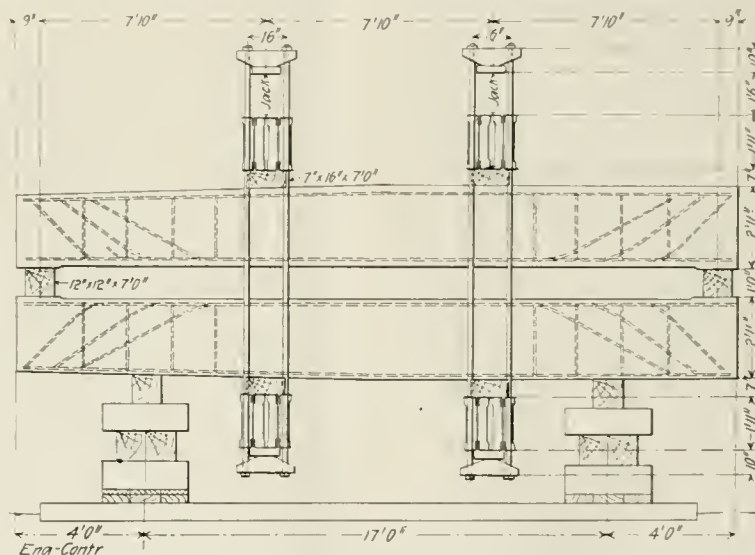


Fig. 1—Diagram Showing Method of Making Test of Concrete Beam.

throughout the length of the slab. No stirrups were used in No. 70. In the slabs made after No. 70 (including No. 71 and No. 72, which were tested) stirrups were used and the bars were bent up farther back from the end and less abruptly. In one-fourth of the bars the inclination started at a point 6 ft. from the end, in one-fourth 4 ft. from the end, and in one-fourth 2 ft. from the end, while as before the remaining bars were horizontal. In these slabs U-shaped stirrups made of $\frac{1}{2}$ -in. corrugated bars were placed vertically at distances of $2\frac{1}{2}$ ft., 4 ft., $5\frac{1}{2}$ ft., and 7 ft. from the ends of the slabs. Each stirrup passed under and included five reinforcing bars and reached nearly to the top of the slab. In addition to the bottom reinforcing bars, four $\frac{1}{2}$ -in. cup bars were placed longitudinally 3 ins. from the top of the slab; and transversely across the slab 2 ins. below the top were twelve $\frac{1}{2}$ -in. and

test. It will be recognized that their great weight made the placing of the slabs a considerable undertaking. They were handled by means of a derrick car of 100 tons capacity, and although this was the first experience of the men in handling the slabs the derrick and the holding device did the work easily and satisfactorily. In inverting slab No. 71, however, the great weight on one rail caused one side of the temporary construction track to settle considerably; and to avoid possible overturning of the derrick car, the hoisting cable was slackened suddenly and the slab was dropped, falling 4 ft. and striking on a pile of stone and against a rail. One corner of the slab was cracked, but so far as the tests show no other injury was done.

The lower slab was supported on 12x12-in. timbers placed transversely across the slab, the distance from center to center being 23 ft. 6 ins., this distance being consid-

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ered the span length in the test. The other slab was then placed right side up on top of these bearing timbers. The timbers were bedded in plaster of paris above and below in order to overcome small irregularities in the surfaces of the slabs. At the one-third points of the span length 7x14-in. yellow pine timbers were placed on top of the upper slab and also on the under side of the lower slab, and bedded in the same manner. Two 24-in. steel girders were placed at each one-third point on top of the timbers of the upper slab, and similar steel girders at the corresponding points below. Sixteen wrought-iron rods (four rods at each of the four points) and thick cast-iron blocks were used to complete the connections. The hydraulic jacks were placed between the upper girders and the upper cast-iron blocks. Each jack had an individual pump and gage. The jacks and

the test made it impracticable to use the apparatus provided, and the deflections measured were the sum of the deflections of the upper and lower beams. It is probable that the individual deflections of the slabs were nearly the same except near the end of the test. In the second test the deflection of each beam was measured, and extensometers were used to determine the lengthening and shortening of the beam and the position of the neutral axis. A second set of extensometers was placed in a vertical position to determine when there was a noticeable increase in vertical distance, as would be the case upon formation of horizontal or diagonal cracks across the line of measurement.

- 468,000 First diagonal crack outside north load.
- 496,000 Numerous small tension cracks.
- 593,000 First diagonal crack lengthening rapidly and becoming more marked.
- 626,000 Cracking along the steel at south end.
- 693,000 In the interval after 488,000 lbs. other diagonal cracks appeared near the first.
- 734,000 First diagonal crack opening wide.
- 801,000 Failed suddenly along first diagonal crack, which reached top just inside the load point.

The results of the test of No. 72 are given in Table 1 and in the diagram (Fig. 3)

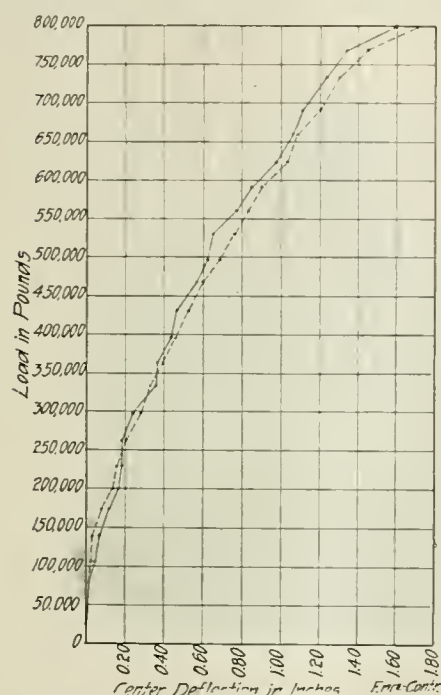


Fig. 2—Diagram Giving Combined Deflections of Beams Nos. 70 and 71.

gages had previously been calibrated; the loads given include the necessary corrections. The load was applied in varying increments, but the amount was kept equally divided among the four jacks. The timber pieces formed adjustable bearing plates over the unevenness of the slabs, and there was evidently a good distribution of the load over the full width of the slabs. It seems sufficiently accurate to consider the distance from center to center of supports as the span length. In general, it may be said that the action of the jacks, the uniformity of the results and other circumstances indicate that the testing apparatus was trustworthy within the limits which may be considered necessary for the purposes of the test.

In the first test the only measurements taken were the deflections of the slabs. The high wind prevailing at the time of

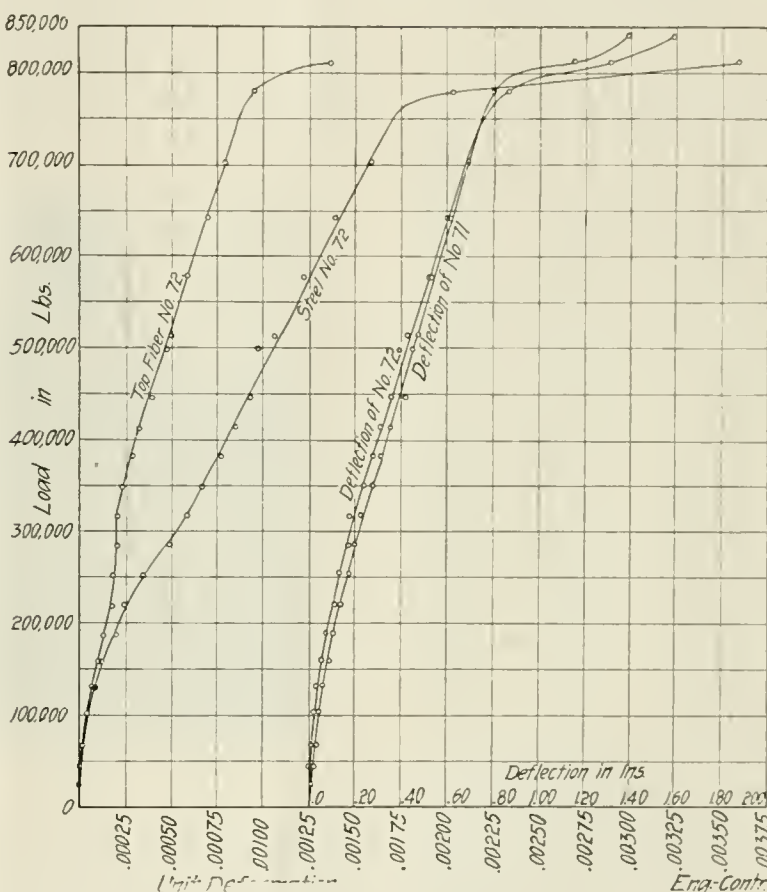


Fig. 3—Diagram Showing Loads, Deflections and Unit Deformations.

The results of the tests are given in the table and diagrams. The diagram (Fig. 2) gives the combined deflections of No. 70 and No. 71. The following are notes of the test of No. 70. It should be borne in mind that the condition of the surface of the slab was not favorable to the early discovery of cracks.

- | Load, Lbs. | Effect of Load. |
|------------|--|
| 25,000 | This load is assumed to be weight of testing apparatus, men and initial tension on rods. |
| 333,000 | First tension crack at center of top slab. |
| 364,000 | Small tension crack at north load of top slab. |
| 432,000 | Second tension crack near center of top slab. |

The calculated stress in the steel is based on the formula for resisting moment, $0.87 A_f d$, where A is the area of the reinforcing bars, f is the stress, and d is the distance from top of slab to center of bars, called here $30\frac{1}{2}$ ins. The surfaces of No. 71 and No. 72 were coated with whitewash and marked off in 6-in. squares, and the position of the cracks at the different loads was noted and traced in pencil as the test progressed. The cracks were afterward painted with black paint and hence appear greatly magnified in the photographs. The numbers on the photograph, Fig. 4, mark the limit of the cracks at the applied load given for the same number in Table 1. These numbers permit the growth of the cracks to be traced. The smooth white

surface permitted the cracks to be seen while very small, and the tension cracks in No. 72 were noted at much lower loads than in No. 70, Fig. 5, which had not been whitewashed. The measurements on the lower slab, No. 71, in the second test were made with a type of instrument which is not entirely suitable for this form of test, and as the results are somewhat irregular they are not given here. The readings of the vertical extensometers showed a marked increase in the later stages of the test and will be referred to in the discussion of diagonal failure.

As is usual in such tests minute cracks

TABLE 1 SHOWING RESULTS OF TEST OF BEAM NO. 72.

Ref No.	Applied Average		Stress in Steel*		From Bending Moment.
	Load.	Deflection.	Lbs.	per sq. in.	
0	25,000	...	...	...	1,500
1	45,000	...	...	...	2,700
2	67,000	0.01	...	300	4,100
3	103,000	0.02	...	1,200	6,300
4	131,000	0.03	...	2,100	8,000
5	159,000	0.05	...	3,600	9,700
6	189,000	0.10	...	6,000	11,500
7	220,000	0.11	...	7,500	13,400
8	253,000	0.13	...	10,500	15,300
9	285,000	0.17	...	14,700	17,400
10	317,000	0.18	...	17,700	19,300
11	350,000	0.24	...	20,100	21,400
12	382,000	0.28	...	23,100	23,300
13	414,000	0.31	...	25,800	25,300
14	447,000	0.36	...	27,900	27,300
15	480,000	0.40	...	29,400	29,300
16	514,000	0.43	...	31,800	31,400
17	578,000	0.52	...	36,900	35,300
18	643,000	0.61	...	42,000	39,300
19	704,000	0.70	...	47,700	42,900
20	780,000	0.88	...	61,200	47,700
21	811,000	1.32	...	108,000	49,600
22	840,000	1.00	...	...	...

*Add 2800 lb. per sq. in. for stress due to weight of slab.

Notes: (0) This load of 25,000 lb. is assumed as the weight of testing apparatus and men and the initial tension of rods. After jacks were in operation all but 9,000 lbs. was indicated by readings of Jacks. The "Average Extensometer Readings" are for a gauge distance of 50 inches. Short tension crack just inside south load point. Numerous tension cracks.

(7) Vertical cracks just outside load points.

(10) More cracks outside of load points.

(21) Tension cracks opening wide.

(22) Maximum load. Tension failure.

become visible in the concrete on the tension side of the beam between the load points as the load was applied and on the outside of the load points at higher loads. These cracks grew in height and became more marked as the load was increased. In the first test (No. 70 and No. 71 together), in which the beams did not fail by the reinforcing steel stretching up to the yield point, these cracks closed up upon the release of the load to such an extent as to be scarcely detectable. In No. 70 (not whitewashed) the first tension crack was noted at an applied load of 333,000 lbs. and numerous tension cracks at 496,000 lbs. In No. 72 (whitewashed surfaces) the first

tension crack was noted at 159,000 lbs. and numerous tension cracks at 189,000 lbs. It will be seen from the photographs that some of these minute cracks reached points 12 ins. from the top of the slab before the reinforcement was stressed to its yield point. Even when they had thus grown their size at the bottom was minute.

Outside the load points (i. e., in the outer thirds of the beam length) diagonal cracks appeared, frequently forming from the top of a vertical crack already visible and extending diagonally upward and downward at the same time. In No. 70 the first diagonal crack was visible at an applied load of 468,000 lbs. and in No. 72 cracks became distinctly diagonal at 417,000 lbs. The diagonal cracks developed with the addition of load, but the form of this development was not the same in No. 70 and in No. 72. In No. 70, the slab without stirrups and having the bars bent up abruptly near the ends, one main diagonal crack formed out-

of total failure. Finally it failed suddenly by diagonal tension (so called shear failure) at an applied load of 801,000 lbs., the diagonal crack having suddenly extended to the top of the slab and opened wide. At the same time the horizontal crack which had formed along the reinforcing bar (by the action of vertical tension) lengthened and the bar pulled away from the concrete above. The characteristic of the test was the formation of main diagonal cracks at either end and the final sudden failure of the beam by diagonal tension. In No. 72 the presence of the stirrups and the changed position of the reinforcing bars at the ends were sufficient to resist the diagonal tension developed. Although the diagonal cracks were numerous and although some of them finally extended to within 12 ins. of the top face of the slab, they remained small and fine and were well distributed. They lacked the growth and concentration which are apparent in fail-

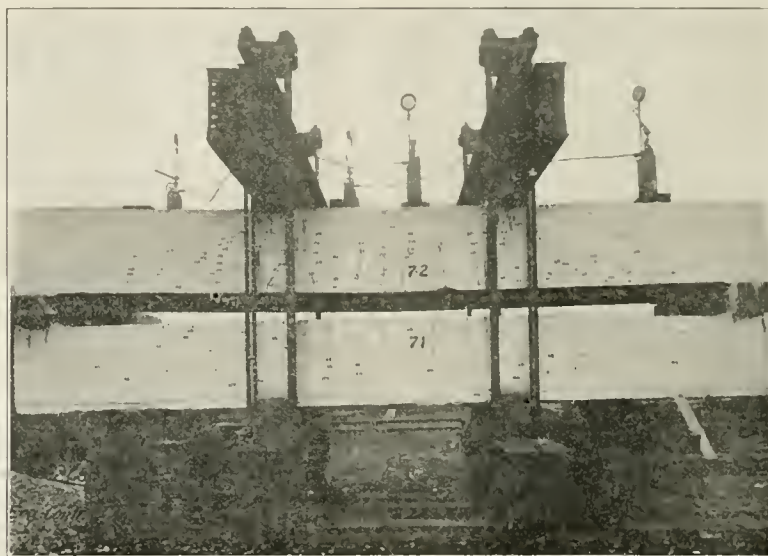


Fig. 4—View Showing Tension Cracks at Maximum Load.

side each load point, making an angle of about 35° with the horizontal. While a few others became visible, these main cracks enlarged and the final failure of the slab was along one of them. In No. 72 (whitewashed surfaces) several marked diagonal cracks had extended for some distance at the load of 480,000 lbs. Some of these finally extended to within 12 ins. of the top face of the slab, but they remained small and fine and were well distributed over the beam.

The manner of failure of No. 70 and No. 72 was quite different. Although it is evident from calculations that the steel of the reinforcing bars in No. 70 had nearly reached the yield point, there was no evidence of this in the appearance and action of the beam at the time of failure. At a load of 593,000 lbs. the main diagonal crack outside of one load point was seen to be extending rapidly and at 731,000 lbs. it was opening wide. It was evident for some time that the beam was on the verge

ures by diagonal tension in beams without metallic web reinforcement. The tension cracks in the middle third of the beam extended upward as the load was increased and at 811,000 lbs. nine of these were visible to within 12 ins. of the top of the slab. At this load the tension cracks were opening wide, indicating that the yield point of the reinforcing steel had been passed. The maximum load applied was 840,000 lbs., but above 800,000 lbs. the deflection increased rapidly. It seems evident that a load of 811,000 lbs. would not have held long and the maximum load applied held but momentarily. After the maximum load was reached, the load fell off as the deflection was increased. The characteristic of the test of No. 72 was slow failure by tension of the steel, without sign of compression failure and without sign of impending failure by diagonal tension. The effectiveness of the stirrups and the bending of the bars at the ends is made evident by the test. This is the more important as the di-

agonal tension failure may give little warning and may develop with repetitions of lower loads. It may be noted that on the next day the test was continued until there was a deflection in No. 72 of $3\frac{1}{2}$ lbs., and the load applied was nearly 800,000 lbs. Upon release of load there was a recovery of 1 in. in the deflection. At this time the stretch of the steel and the consequent concentration of the compressive stress were so much that there was considerable crushing of the concrete. Slab No. 71, which was used as the lower beam in both tests, seems not to have suffered from the first test, the cracks closing up upon release of load. In the second test the tension cracks opened up and at the maximum load there was evidence of the steel being stretched beyond the yield point. It should be noted that on account of its inverted position and the location of the supports the bending moment developed in the lower beam was somewhat smaller than that in

that the real tensile deformation would be somewhat less.

The vertical shearing stress in the concrete at the breaking load of No. 70, calcu-

lated by the formula $V' = \frac{V}{bd}$ (where V'

is the total vertical shear at the point where the crack begins, including the shear due to weight of slab, and b is the width of the slab, and d' is the distance from the center of the reinforcing bars to the center of gravity of the compression area of the concrete (called here 0.87 of the depth to center of reinforcing bars), is 209 lbs. per sq. in. The vertical shearing stress so calculated may be used as a means of comparison of the resistance to diagonal tension. A value of 209 lbs. per sq. in. is a high one for a beam without stirrups and having bars bent up abruptly at the end, and shows a good quality of concrete. The value of τ for the applied load of

the middle of No. 70, calculated by the usual methods, and including the effect of the weight of the beam, was 51,700 lbs. per sq. in. at the maximum applied load of 801,000 lbs. As the tension cracks in the concrete closed up after the failure of the beam it would seem that the steel had not been stretched beyond its yield point. In No. 72 the calculated tension in the reinforcing bars, including the effect of the weight of the slab, was 51,000 lbs. per sq. in. for the maximum applied load of 840,000 lbs. For applied load of 811,000 lbs., where the yield point evidently had been passed, the calculated tension is 52,300 lbs. per sq. in. These values check up with the yield point of the material within the limits of variation of such material.

The compression in the upper fiber calculated by the ordinary methods runs up to a high figure, as is usual in tests of beams having a considerable amount of reinforcement. Assuming the neutral axis to be at 0.43 of the depth to the reinforcing bars, and using the ordinary straight-line formula, the compressive stress in No. 72 at the maximum load was 3,190 lbs. per sq. in. Using the parabolic formula and considering that the compressive deformation is one-half of the ultimate compressive deformation of concrete, the calculated stress is 2,870 lbs. per sq. in. Even at this high calculated stress there was no sign of compression failure until after the steel had stretched beyond its yield point. Comparing the deformation developed with that of other tests it seems probable that the beam would have taken at least one-third more compressive stress before failure in compression at first loading. Of course, repetitive loading at any such high load might soon have injured the beam.

The tests showed that the concrete was of excellent quality and that the slabs acted similarly to high grade test beams made and tested in laboratories. The uniformity and regularity of these large beams are shown in various ways in the tests. As these slabs may be presumed to be fairly representative of the slabs fabricated for the work, the tests will add confidence in the quality and soundness of the reinforced concrete used in this work. The action of the concrete in compression under the high stresses developed was quite satisfactory. The tests show the effectiveness of stirrups and of the method used in bending up bars at the end in resisting diagonal tension. As diagonal tension weakness is particularly undesirable, because of possibility of sudden failure and of injury with repeated application of the load and because of the difficulty of detecting incipient failures when the sides of the beam are not available for inspection, ample safety against these stresses is important. Failures by tension of the steel and by compression of the concrete give warnings through abnormal deflections and in other ways and are less likely to lead to serious results.

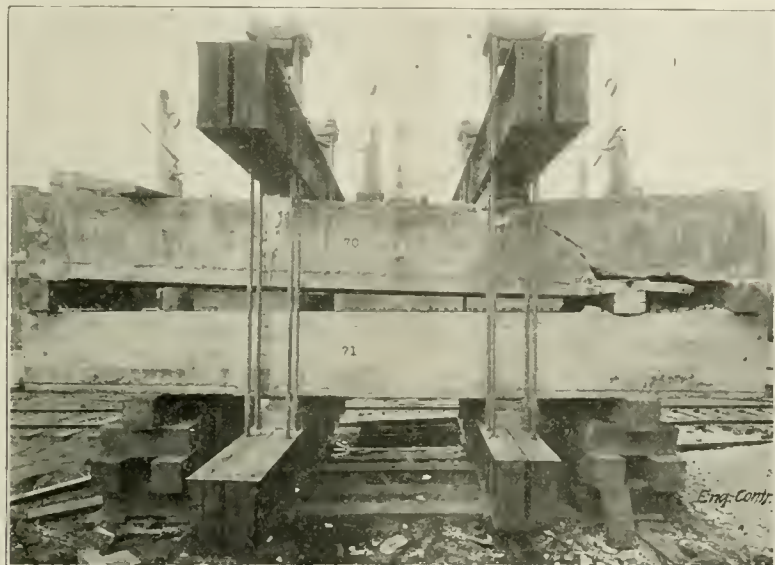


Fig. 5—View Showing Failure of No. 70 by Diagonal Tension.

the upper beam. There was no sign of impending failure by diagonal tension.

The proportionate depth of the neutral axis for the amount of reinforcement here used, based upon ordinary assumptions, would be in the neighborhood of 0.43 to 0.47. Calculations from the observed deformations give a position which seems abnormally high, averaging during the later stages of the test about 0.34 of the distance from the top of the slab to the center of the reinforcing bars. An examination of the original data suggests that there was slip in the top extensometers and that the neutral axis must have been lower than shown by these results. The vertical position of the line for top fiber compression given in the diagram between loads of 220,000 lbs. and 320,000 lbs. (showing little increase in the compression) shows where the trouble lies. It should be noted that with such slip of the upper extensometer the real compressive deformation would be greater than that given in the diagram, and

468,000 lbs., where the first diagonal crack was noted, is 125 lbs. per sq. in., and for the applied load of 593,000 lbs., where the main diagonal crack was seen to be lengthening rapidly and becoming more marked, was 156 lbs. per sq. in. In No. 72 the value of the vertical shearing stress, τ , at the maximum load applied is 220 lbs. per sq. in. As there was no sign of impending failure and as the diagonal cracks closed up after the failure of the beam, it is seen that the provision against failure by diagonal tension was very satisfactory. At the load of 447,000 lbs.—giving a vertical shearing stress of 120 lbs. per sq. in.—there was a marked increase in the reading of the vertical extensometer at one end of the beam and an evident development of the diagonal crack. A similar development was noted with the extensometer at the other end at a load of 514,000 lbs. Above these loads the readings of the vertical extensometers increased rapidly.

The tension in the reinforcing bars at

Mr. A. S. Balwin is chief engineer of the Illinois Central Railroad, Mr. R. E. Gaut is engineer of bridges and buildings and Mr. F. L. Thompson is assistant engineer in charge of the Grand Crossing track elevation work. To them and to C. C. Chandler, chief draftsman, and other employees of the department of bridges and buildings is due credit for assistance and suggestions on the tests, as well as to Messrs. D. A. Abrams and W. R. Robinson of the University of Illinois Engineering Experiment Station.

Method and Cost of Constructing Concrete Piers for a Highway Bridge.

BY HENRY A. YOUNG,* ASSOC. M. AM. SOC. C. E.

The following data were obtained in building the piers for steel bridge No. 2 of the Huntley Project, Montana, one of the U. S. Reclamation Service projects recently completed. The bridge span was 60 ft., the main piers being 19 ft. 4 ins. long, 4 ft. wide at the bottom, 18 ins. wide at top and having a height of 11 ft. 6 ins. above the footings. The footings were 2 ft. 6 ins. thick, 22 ft. 4 ins. long and 7 ft. wide. Each pier was flanked by light wing walls, 16 ins. wide at the bottom and 12 ins. wide at the top, 7 ft. 8 ins. high and 11 ft. long, having footing 16 ins. by 3 ft. 4 ins.

The bridge carries a highway over the main canal, the piers being located in the banks at either side. They act as retaining walls and were figured for 60 lbs. per sq. in. tension in the back of the wall. Each pier required two days to build, steel bars being inserted in the rear of the wall where work was stopped the first day.

All labor was for 10-hour days, but is reduced to equivalent 8-hour days as required by the department records.

A Municipal Engineering and Contracting Co.'s $\frac{3}{4}$ cu. yd. cubical mixer was set between the two piers and at one end. Two Ransom carts were used in placing the concrete. The mixer was fed by wheelbarrows. The tops of the forms were about 8 ft. above the ground, and the concrete had to be wheeled up runways to this height.

The work was done in December, 1905, the weather being very cold. This necessitated the heating of the water and sand. The piers were covered at night and stoves placed around the forms were left burning all night after concreting. Water, cement, etc., were hauled over level ground about one-quarter of a mile. Sand and gravel were hauled from a pit for a quarter of a mile on a down grade. The wheel at the gravel pit was about 30 ft., the material being screened into a bin. The maximum size gravel used was 3 ins. The cost of sand and gravel delivered is recorded in the table.

The forms were plain and easily built. Full charge is made for the lumber used in the forms, which is not entirely correct, as

much of it was in condition to be used over again on other work.

Concrete was put in wet and well spaded. A 1-in. course of 1-2 mortar was placed on the copings of main piers and wing walls. Chamber strips were used on all sharp angles. In the footings, the concrete was mixed in the proportion of 1-2 $\frac{3}{4}$ -7 and in the piers 1-2 $\frac{1}{4}$ -5 $\frac{1}{2}$.

The excavation was mostly in a dry, sandy clay, and was done chiefly by hand, though teams were used to clear the right of way about the bridge. The average depth of cut at each pier was about 5 ft. Water was struck near the bottom, requiring pumping and some shoring.

The work was done by contract, but actual costs are given whether borne by the contractor or by the department, and no allowance is made for engineering or general office expenses.

The quantities consisted in the excavation of 75 cu. yds. of earth and the laying of 99 cu. yds. of plain concrete.

TABLE SHOWING COSTS OF CONCRETE PIERS FOR A HIGHWAY BRIDGE.

Excavation, Class I—				Cost per	
Classification.	Days.	Rate.	Total.	cu.yd.	\$
Superintendent	2	166.67	11.11		
Foreman	2 $\frac{3}{4}$	50.00	4.58		
Laborers	11 $\frac{1}{4}$	2.00	22.50		
Teams	3 $\frac{3}{8}$	3.60	13.05		
Excavating 75 cu. yds. dry earth.			51.24	0.68	
Concrete, Class I—					
Superintendent	10	166.67	55.56		
Foreman	5 $\frac{1}{2}$	50.00	9.17		
Superintendence			64.73	0.654	
Forms:					
Boss carpenter	13 $\frac{3}{4}$	3.20	44.00		
Carpenters	16 $\frac{3}{8}$	2.80	45.85		
Laborers	6 $\frac{3}{4}$	2.00	13.50		
Labor on forms for 99 cu. yds. concrete			103.35	1.044	
Lumber, 5,000 ft. B. M.		20.25	101.25		
Nails, 1 $\frac{1}{2}$ kegs.		3.20	4.80		
Materials for forms for 99 cu. yds. concrete			106.05	1.07	
Mixing and Placing:					
Laborers	55 $\frac{1}{2}$	2.00	111.25		
Fireman	4 $\frac{7}{8}$	2.40	11.70		
Labor (99 cu. yds. concrete)			122.95	1.242	
Sand, 27 cu. yds.		.66	17.82		
Gravel, 83 cu. yds.		.66	54.78		
Cement, 118 $\frac{1}{2}$ bbls.		1.86	220.41		
Coal, 3 tons.		3.25	9.75		
Extra steel, 106 lbs.		.0288	3.05		
Materials (99 cu. yds. concrete)			305.81	3.09	
Average cost per yd. of 99 cu. yds. plain concrete = ...					7.10

LETTERS TO THE EDITORS.

Destruction of Portland Cement by Alkali.

Sirs: I have been much interested in the letters in recent issues of ENGINEERING CONTRACTING relating to this important subject, and am pleased to read that Mr. M. E. Sullivan makes such pertinent comments. As contractors must regard the matter seriously, I venture to add to the discussion.

Several years ago I noticed the same occurrences. Unable to account for the trouble through bad materials, etc., it induced me to give many months' attention to the matter. I found that the great reservoir at Bonn, Germany, had been destroyed from some unaccountable cause. The German Association of Portland Cement Manufac-

turers had deliberated upon the question and had come to the conclusion that the destruction of the Portland cement reservoir had occurred through the action of carbon dioxide in the water; further elucidation seemed impossible. Dr. Stutzer and Dr. Hartler then pursued the investigation.

They found that the corrosive action of CO₂ is helped by the influence of nitrifying bacteria when the water contains oxidizable nitrogenous matter.

They examined the brownish mud (poor in lime) by washing it thoroughly with sterilized water, and introducing small quantities into solutions containing respectively 1 gram of ammonium sulphate or 1 gram of sodium nitrite per litre.

At the end of six days the first described solution gave distinct indication of the presence of nitrites, from which it was initially quite free, and in 14 days the nitrite action was very strong, while the ammonia reaction was extremely feeble, thus demonstrating the presence of nitrifying bacteria, and the formation of *nitrous acid* capable of attacking the lime in the cement.

In the case of the sodium nitrite solution the complete conversion of the nitrite into nitrate, under the influence of the cement, took a considerable time to effect.

The formation of nitrites is, however, a more important factor, since it is the production of acid bodies (nitrous acid and carbon dioxide) that renders corrosion of the cement possible.

A microscopical examination of the solution revealed the abundant presence of a hypo-microbium, though the separate organisms acting in the two different stages of oxidation were difficult to identify.

If possible, I should like to obtain a fragment of the destroyed cement.

In connection with this action of CO₂ I notice in the technical journals that experiments are being carried out in Germany to investigate the dangers arising from rust to the reinforcement. Their experiment embodies forcing CO₂, O, and water vapor into the mass of concrete so as to produce rust on the metal. As no attention has been given to the action of CO₂ upon the cement and as the beams were under saturation only 27 hours, it does not appear that their conclusions, so far as concerns the "rapid rusting test," can have any value.

Yours faithfully,

HILDER DAW.

Montreal, P. Q., July 21, 1908.

Bids for furnishing the Isthmian Canal Commission with 8,270,000 lbs. of dynamite for use on the Isthmian canal were opened July 21. The E. I. Du Pont De Nemours Powder Co. at \$907,460 was reported to be the lowest bidder. Delivery of the dynamite is to begin Oct. 15 and to continue at the rate of 1,000,000 lbs. per month.

*Engineer in charge Water-works, Camagüey, Cuba.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Digging Wet Holes, with Some Comments on Furnishing Special Clothing for Workmen.

The holes in question were dug in connection with building a shore protection along a tidewater bay, the ordinary rise of the tide being between 2 and 3 ft. The holes had to be dug ahead of a pile driving crew, so that piles could be driven in the hole.

A crew of men dug the holes with picks and shovels and used a small cellar drainage or bilge pump made of galvanized iron for keeping the holes dry. The holes were 4x5 ft. in size and averaged 3 ft. in depth, large enough for a man to work in it easily. The material was a sandy clay and black loam of decomposed vegetable matter and in most cases water flowed into the hole from the surrounding marsh or from the bay at a depth of about a foot. Some roots and old drift wood were encountered and had to be cut with mattocks. In nearly all cases the material was stiff enough to stand up by itself, so there was little trouble with the sides of the holes caving in. On the other hand nearly all the holes were lower than high tide, and the tide filled some of the holes with sand before the piles were driven, necessitating the re-excavation of the hole. The average amount of excavated material from each hole was 60 cu. ft. and it was found that the refilling of some of the holes added an average of 12 cu. ft. additional excavation to each hole, making the total excavation 2.66 cu. yds. per hole.

The foreman and a gang of about 12 men did the work. When the holes were dry, which was seldom the case, one man worked in a hole, but if the hole was very wet, two men worked at a hole, as one man was needed to run the pump. The sand and grit in the holes not only quickly used up the leather sucker of the pump, but also the galvanized iron sides of the pump. These pumps of five or six foot lengths, 2½ to 3 ins. in diameter, are worth from \$5 to \$6, and within a few days they have to be repaired, and within 4 or 5 weeks are entirely worn out. When pumping of this character has to be done such pumps are not only inefficient, but are quite expensive. A few diaphragm pumps would not only have done better work, but although they cost much more than the bilge pump, in as much as they last longer they would have been cheaper in the end.

The tools used in this work consisted of 12 shovels, 12 picks, 6 pumps, 6 mattocks and a water bucket. Their cost was about

\$50 and the monthly depreciation would be from \$25 to \$30, making a charge for tools of about one dollar per day; this is exclusive of rubber boots. In order to hold the men at work it was necessary to furnish them with rubber boots, a dozen pairs of the best costing about \$40. These boots are quickly snagged and injured, thus rendering them useless, hence to renew them a charge of \$2 per day is made for boots. The boots are furnished free to the men, and in order to protect their legs as well as their feet, hip boots are generally used.

The supply of boots and other clothing to men, in order to keep them at work under trying circumstances, is often a necessity, especially with laborers. These men's wages are rarely large enough to admit of their clothing themselves properly under adverse weather conditions or when working in unusual places, and it devolves upon the contractor to stand this expense. Not only are gum boots furnished to men working in deep foundations or trenches, but under some circumstances oil skin coats and trousers and hats are furnished to men working in wet places, or when kept at work during rainy seasons.

Laboring men generally insist on stopping work as soon as the first sprinkle of rain starts, and many contractors have found, especially those working in large cities, that they can keep their men at work by furnishing them with the necessary clothing. A prominent contractor of New York, in commenting upon these conditions a short time ago, said:

"We have 275 men working here in this downpour of rain, and the job is advancing as though there was no rain. It is a great plan and I will venture to say that many other large companies will follow in our steps and furnish their men with garments to protect them from rain and snow. In a year there are more than 30 rainy days. A month's saving in time means a great deal to a big company that has millions of dollars' worth of contracts awaiting the efforts of outdoor laborers."

City departments having in charge water works and sewers, often have to furnish employes special clothing of this nature. One of the editors of this journal has for some years followed this practice in outdoor work. Some few years ago, in carrying on steam shovel excavation, work was done both day and night every day in the year, no matter how inclement the weather, and he found that by supplying the men with rubber clothing in summer and warm waterproof clothing in winter he was able to keep his steam shovels going all the

time. Without this, a daily pay roll of men paid monthly salaries, amounting to about \$60 per day for two shifts, was a direct charge against the work done in good weather, while with a charge of about \$10 per day for clothing, enough work could be done even in bad weather to make current expenses, keep the work well organized and going, and frequently making some profit. It also meant a force on the work to take care of threatened washouts and similar disasters that occur during bad weather.

It is necessary to teach the men that such clothing is not theirs and must be taken care of just as they care for the tools and machine, and on a job where a large number of men are worked a man must be appointed to look after the issuing and collecting of the clothing. On a small job the foreman can do this. The same garment must be issued to the same man each day. Laborers become very jealous of other men who get the clothing to wear that they have worn, and disputes are liable to occur from this, and besides by assuring the man that he will have the same garment each day, he takes better care of it. As far as possible in issuing new garments, all of the same crew or gang should be given new garments at one time, otherwise ill feeling may arise among the men, which will mean less work done. On the other hand rivalry between gangs is generally a spur to them to do extra work, and is a benefit to a contractor.

To return to the hole digging. The wages paid by the contractor for a ten hour day were:

Foreman	\$2.50
Laborers	1.50
Waterboy	1.00

In all 226 holes were dug during a month's work, the men working during that time enough to amount to 12 days. The cost of this was:

Foreman, 12 days.....	\$ 30.00
Laborers, 109 days.....	163.50
Water boy, 12 days.....	12.00
Tools, 12 days.....	12.00
Rubber boots, 12 days.....	21.00
Total	\$211.50

The cost per hole for each item was:

Foreman	\$0.13
Laborers	0.72
Water boy.....	0.05
Tools	0.05
Rubber boots.....	0.10

Total

The cost per cu. yd. of excavated material was:

Foreman	\$0.05
Laborers.....	0.27
Water boy.....	0.02
Tools	0.02
Rubber boots.....	0.04

Total

This shows that a man dug about two

holes per day, and he handled about 6 cu. yds. of material per day. The cost of the labor was about two-thirds of the total cost of the work, exclusive of superintendence; that has not been considered in this article. The cost of superintendence of such a small item of work would be very small, seldom over a cent or 2 cents per cu. yd., the cost depending upon how much work of other kinds was being carried on under the same superintendent, time keeper and office force.

During the month of June 1,134,032 cu. yds. of material were removed from the Culebra Division of the Isthmian canal. The following was the equipment in use on the Culebra Division June 1, 1908: Steam shovels, 60; American locomotives, 149; rebuilt French locomotives, 7. Cars—50-ton steel flats, 183; Western dumps, 18-yd., 110; Western dumps, 12-yd., 258; Oliver dumps, 12-yd., 132; Western steel car and foundry flats, 40-ton, 300; Lidgerwood flats, 40-ton, 1,267; I. C. C. gondolas, 40-ton, 8; labor cars, 47; work service cars, 38; camp cars, 6; Goodwin dumps, 30-yd., 14; Ingoldsby dumps, 30-yd., 7. Total cars, 2,370. Rock drills—Chicago rock, 18; Kellar air-hammer rock, 21; Ingersoll-Sergeant rock, 87; Rand rock, 41; Sullivan rock, 74. Channellers—Sullivan, 4; Ingersoll-Rand, 2. Rock crushers, 2; spreaders, Jordan, 3; McGann, 14; unloaders, 36; track-shifting machines, 5; dredge, clam-shell and orange-peel, 1; wrecking cranes, 20-ton, 2; 25-ton, 2; 75-ton, 1; pile drivers, 10. On the above date 7,350 men were employed. The dynamite used in May amounted to 552,650 lbs.; 351,350 lbs. 60 per cent., and 201,300 lbs. 45 per cent.

In connection with the construction of the fourth set of oxidizing waterworks filters at the Ynisypo Reservoir of Newport (England) an interesting method was employed for transporting the filters to their destination by water. This method, according to The Surveyor was as follows: All the internal and external fittings were first removed and all openings in the filters plugged or secured with blank flanges. The filters were then launched into the reservoir, towed across, hauled on to the bank on the opposite side, and rolled down to the site selected for their erection. The floating across the reservoir was accomplished without the slightest difficulty, and the time occupied in launching and landing each cylinder was 1¼ hours. The filtering material, pipes and fittings were also taken across on a raft. The filters form part of a plant to deal with 2,000,000 gallons per day.

The State Canal Board of New York has approved plans for Contract No. 20 calling for dredging the Mohawk River in connection with Barge Canal Work and will at once call for bids. The estimated cost is \$4,173,000.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Cost of Reconstructing Street Railway Cable Line Into Electric Line at San Francisco, Cal.

In our issue of March 11, 1908, we described and illustrated some of the special machines and methods being employed by the United Railroads of San Francisco in reconstructing its old cable lines into electric lines. At that time the costs of the work were not available, but since then the reconstruction of one line has been completed and the actual costs segregated. These costs have been furnished us by Mr. B. P. Legaré, engineer maintenance of way and construction, and we give them in the accompanying table. Preliminary to this tabular statement of costs we give the following notes of the general character of the work and of the kinds of work entering into each of the several cost items.

The work consisted of reconstructing standard gage cable tracks into standard gage electric, consisting of 9-in. 109-lb. rails laid on ties, 2-ft. centers, with combination 12-hole joint plates, and tie rods every 10 ft. The ties laid on 8 ins. of rock ballast with a concrete stringer under the rails between the ties, basalt block runners on both sides of the rail, concrete base for pavement from the top of the ties to within 2 ins. of the top of the rail and 2 ins. of asphalt wearing surface.

Item 1 includes removing old blocks, asphalt, yokes, old track, etc., digging trench in which the new track will be laid, hauling ballast to the job and unloading, crushing or breaking same, tamping ties, surfacing and lining track, hauling concrete material, unloading, mixing, placing, and tamping same.

Item 2 includes hauling rails, ties, spikes, and plates, and unloading same; spacing ties, laying, joining, and spiking rails, drilling for tie rods and placing same, drilling rails, placing bonds, and tightening joint plate bolts.

Item 3 includes hauling and unloading blocks, asphalt, and sand for paving, laying block pavement, runners or tothing, and grouting same.

Item 4 includes loading and hauling old steel, concrete, dirt, and all debris from the job, both during and after construction; also repairs to all damaged street pipes or wires and conduits.

Item 5 includes teaming.

Item 6 includes material and labor in laying asphalt wearing surface.

Item 7 includes superintendence.

Item 8 includes all materials—rails, ties, plates, bolts, spikes, tie rods, bonds, cement, crushed rock, paving blocks, and sand.

In the figures given below no credit has been allowed for the value of scrap steel and old blocks. These figures are as follows:

Item 1, cost per lin. ft. of track.....	\$1.090
Item 2, cost per lin. ft. of track.....	0.174
Item 3, cost per lin. ft. of track.....	0.979
Item 4, cost per lin. ft. of track.....	0.195
Item 5, cost per lin. ft. of track.....	0.025
Item 6, cost per lin. ft. of track.....	0.600
Item 7, cost per lin. ft. of track.....	0.087
Item 8, cost per lin. ft. of track.....	2.780

Total cost per lin. ft. of track...\$5.030

Items 1 to 7 are labor costs and item 8 is cost of material, so that we have:

Cost for labor per lin. ft. of track.....	\$2.25
Cost of materials per lin. ft. of track..	2.78

Total labor and material.....\$5.08

Regarding this total cost Mr. Legaré writes: "You will find that these figures are exceedingly low for work on the coast, on account of wages and the distance from the markets, and I doubt if the same figures can be maintained. However, I believe that we can always do this kind of work, by our present methods, for something below \$6 per lin. ft. of track."

In a reply to a protest against the suggested increase in freight rates Mr. W. C. Brown, Vice President of the New York Central & Hudson River R. R., stated that during the 10 years from 1898 to 1908 there had been the following increases in the cost of materials used on railroads:

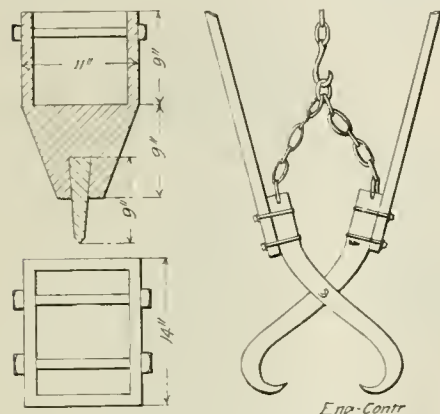
	Per cent.
Angle bars	50.0
Gray iron castings	37.5
Malleable iron castings	21.3
Bar iron	42.8
Cut nails	95.4
Wire nails	45.6
Cast iron pipe	87.8
Steel rails	47.3
Track spikes	25.9
Cast iron car wheels.....	25.0
Barbed wire	32.0
Bridge timbers	80.0
Cross ties	76.0
Car siding	90.0
Locomotives	68.3
Box cars	72.8
Car axles	51.0

A new Laboratory has been opened at Lievin, France, under the auspices of the Central Committee of French Coal Mines, for the purpose of carrying out investigations into the causes of explosions in coal mines.

Methods and Costs; Some Old, Some New.

The Weathering of Coal.—As the result of some experiments on the weathering of coal conducted at the engineering experiment station of the University of Illinois the following conclusions were reached: (1) Submerged coal does not lose appreciably in heat value. (2) Outdoor exposure results in a loss of heating value varying from 2 to 10 per cent. (3) Dry storage has no advantage over storage in the open except with high sulphur coals, where the disintegrating effect of sulphur in the process of oxidation facilitates the escape of hydrocarbons or the oxidation of the same. (4) In most cases the losses in storage appear to be practically complete at the end of five months. From the seventh to the ninth month, the loss is inappreciable.

Chisel and Grapple for Removing Sunken Timber.—In excavating for the foundation of a bridge pier considerable old timber was encountered. To remove this timber the chisel shown on the left in

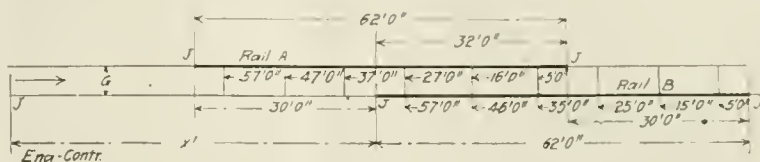


Chisel and Grapple.

the accompanying sketch was used. This chisel was bolted to a pile butt and after being placed over the timber to be removed was driven through it by the pile driver. In cases where the timber thus detached was too water logged to come to the surface the grapple, also shown in the sketch, was used. This was made of $\frac{5}{8}$ x 3-in. iron, secured to handles 15 ft. long and manipulated from a scow. After the grapple had been attached to the timber it was lifted by means of the chains which were carried to a car derrick.

To Avoid Drilling Tie Rod Holes.—The following description of a method of laying girder rails has been sent us by Mr. A. W. Saunders, C. E., Johnstown, Pa. Regarding it he states: "I have noticed in several cities men drilling tie rod holes in the girder rails when the street car lines renewed their tracks, which could have been avoided. I do not understand why the rail manufacturers have not explained this in their catalogues. I have timed men drilling these holes; two men, one hr. at 17½ cts. drilled four holes, making the cost per tie rod 17½ cts, including time re-

quired for shifting, digging out for machine, etc. This does not include costs or depreciation of tools. Any way, no matter how little the cost, all can easily be avoided, as the accompanying sketch readily shows. The track laying is in the direction of the large arrow. The tie rod holes are drilled by the manufacturer as indicated. The first 30 ft. of all lengths are alike; beyond 30 they vary. Turn rail 'A' around



A Method of Laying Girder Rails.

for the other side of the track and the rod holes will be as rail 'B.' Take any other lengths of rails—the run of the mill—and they will lay equally as well. The rails must lay in pairs as indicated by the heavy lines, always keeping 30 ft. lead on the right. Bear this in mind when starting and you will have to do no drilling for tie rods."

The Construction of Mattresses for Retention Work.—In a paper on the Mississippi River improvement work read before the Ohio Engineering Society Mr. H. E. Frye describes the method of making mattresses to protect banks where caving or washing is liable to do great damage to the navigable channel or the levee districts. The method of constructing these mattresses is as follows: A loom is built along one side of a barge with an incline extending down to the water: the barge is anchored with the loom side down stream so that the mattress will float away as fast as woven. The weaving is similar to carpet weaving, wire rope being used for warp and refuse lumber for filling. The length and breadth of the mats depend upon the facilities for anchorage and the velocity of the current. When completed stone is evenly distributed over the mat until it is sufficiently loaded to sink when loosened, but being partly held up by the current remains afloat. The upper end being fast to the barge, the main anchor lines extending from the shore pass under the construction barges and are made fast to ropes woven in the mat for the purpose. When all is ready the upper end of the mat is lowered and the lines attached to the barge loosened allowing the upper end of the mat to sink, being carried quickly to the bottom by the current and held there by its load. After the sinking of this shore mat, which at times is several hundred feet long and as wide as the bank requires, the steep bank above the shore line is graded with hydraulic graders and the material allowed to run down onto the sunken mat. After the bank has been graded, a second mat is woven on this slope and likewise covered with stone and planted with willows, which soon form a dense thicket along the bank. The protection of a very

short portion of a caving bank will, at times, shift the current to an extent that will stop the caving and possibly start to filling again. Owing to the expense of this method of revetment its use has been confined to the more important points.

Road Construction Over Swamps and Peat Bogs.—The construction of roads over peat bogs and swamps is often a serious problem. One engineer who has had

a great deal of experience in this kind of work concludes that in general if the road is to be laid over a soft, deep, wet and yielding swamp, it is oftentimes best, if timber is handy, to float the road on a raft made of long poles. This raft is constructed of a bottom course laid longitudinally, with broken joints, and a second course laid transversely and covered with brush. Side ditching destroys the sustaining power of the peat, and drains should be made only at a considerable distance from the road. Telford pavement is not to be recommended for swamp roads, and if macadam is used it is best to have the first covering the thinnest, as there is sure to be some settlement which can be made good by the addition of stone from time to time. In constructing roads of this kind it is desirable to keep the grade line as low as possible, and the filling free from deleterious matter, and the lightest obtainable. In an embankment built over a tidal swamp, a settlement of only 2 ins. was found after the road had been subjected to heavy traffic for over a year. The swamp was a firm peat bog at the elevation of mean high tide, but too soft to sustain a man without his sinking nearly to the knees. The depth to hard bottom was 8 ft. below bog surface. The road is 80 ft. wide, with a 40-ft. carriageway, and the grade line is an incline, varying from 4 to 20 ft. above the surface of the marsh. In constructing a double track trolley road over some tidal swamp land each track was laid on the outer side of an old plank road. This old road had been made, many years before, by laying 3-in. planks transversely on the surface of the meadow. The grade line was about 2 ft. above the meadow and about 2 ft. below occasional high tide. The depths of filling over the planks varied from 4 to 6 ft. and the depth to hard bottom was from 30 to 60 ft. In order to construct the trolley road it was necessary to widen the plank road on either side about 3 ft. beyond the ends of the old planks and to excavate 1 ft. for the subgrade. Great care was taken not to disturb or cut the peat surface, which was fairly firm, although in places it could not be walked upon without sinking in. Boiler house cinders were used for filling.

Method of Re-aligning Steam Pipe for Power Plant, With Examples of Steam Pipe Hangers.

The following account of the methods adopted in re-aligning steam pipes with samples of pipe hangers will be found useful by contractors in erecting and keeping up steam plants on construction work. The account is taken from a communication by James F. Hobart of Willoughby, O., to the "Electrical World" of June 6, 1908:

"The writer was recently called in to ascertain the reason for a certain engine's frequency in breaking out the cylinder head. Four times, within six months, was the unenviable record of the engine, which had never given trouble before the date alluded to. Upon looking the engine over, it was found to be arranged with a very small home-made separator in the steam pipe, close to the throttle of the engine. The steam pipe was a long one, over 150 ft., but it was well insulated with magnesia pipe covering besides being enclosed in a box where it went out of doors from one building to another.

The engine was used for driving an electric generator in a manufacturing establishment and the breaks had occurred in two periods; two of the breaks coming within three weeks of each other in the late autumn, the other two breaks occurring this spring within a week of each other, the last break not yet having been repaired. The first apparatus examined, after looking over the engine, was the boiler, which was a fine high-pressure tubular concern, with dry pipe but no dome. Nothing wrong could be found at the boiler, or at the engine, to cause trouble, and nothing remained to be examined except the steam connection, which was 6-in., screwed-joints, black pipe, evidently of standard make. The pipe extends through two warehouses and was suspended from overhead by means of home-made hangers similar to that shown by Fig. 1, evidently forged from 1/2-in. iron rod by the engineer, when the plant was set up. The hangers were strong enough and there were plenty of them, the timbering of the buildings evidently causing hangers to be located at quite short intervals, say 6 ft. to 8 ft. in order to prevent unsupported pipe lengths of 14 ft. to 16 ft.

Nearly all the space through which the pipe extended was dark, and the examination had to be by lantern-light. By chance, while wandering through the factory, on the floor above the steam pipe, something led the writer to note that the floor was exceedingly uneven, in some places appearing several inches higher than other places only a few feet distant. A closer examination led to the discovery that some portions of the floor were heavily loaded with stock to be manufactured, and the floor had settled badly where the stock was piled the heaviest.

A question or two brought out that the stock had been in the mill only a little

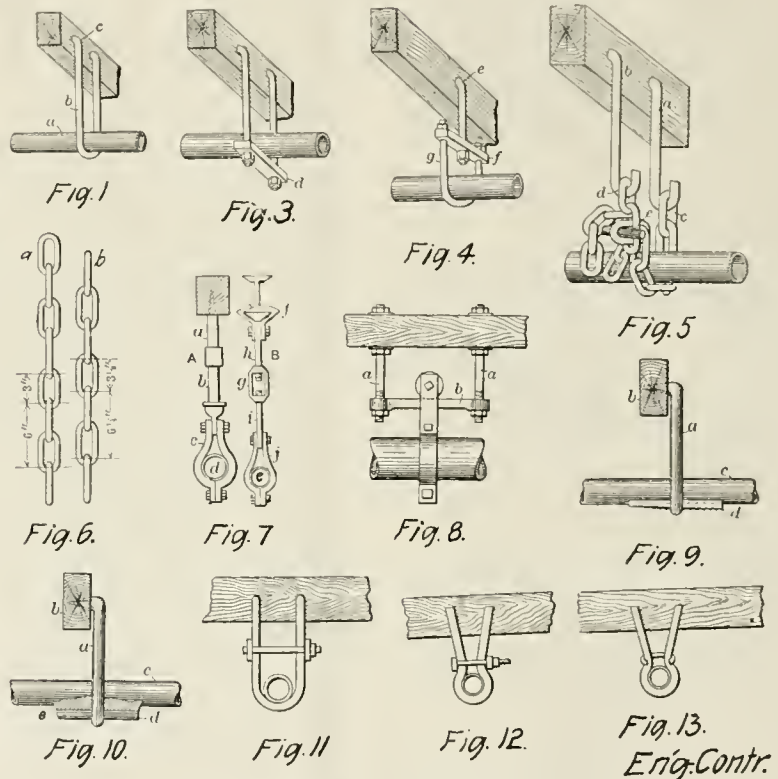
more than two weeks, and was put in about the time the engine broke down.

The cause for the breaking of four cylinder heads by water in the cylinder was thus evident. The steam pipe had been forced down by loads of stock piled on the floor which supported the pipe. Packers were thus formed in the steam pipe which partially filled with water when the engine was running. When an extra and sudden call for steam came on, about an hour before sundown, each time the head blew out, the increased flow of steam evidently caught up some of the water in one of the pockets near the boiler and carried that portion of water along with the steam.

Several more pockets well filled with water were in the path of the steam, and the result was that all the pockets were emptied by the rush of steam, and by the

simultaneous course from boiler to engine with the line *m, n, o*, stretched tight along its 150 ft. of length. The pockets at *a, b* and *c* will be noted. The arrow denotes the direction of flow through the pipe and the water originally picked up in pocket *a*, reinforced by the water from pockets *b* and *c*, was sufficient to flood the little separator and push out the cylinder head of the engine.

No light was obtainable in the mill, except from petticoat lamps, lanterns and candles. Some of the latter were procured, the line stretched "neck and heels" at *f*, between targets *d* and *e*, then target *h* was put into position as shown. The candles *g* and *h* were fastened to the back of each target by three wire nails driven on an angle and the candles slipped between them. Then with the eye at *i*, target *h*



Examples of Steam Pipe Hangers.

time it approached the engine, the steam pipe was almost full of water of condensation, which simply drowned out the little separator and swept down into the engine and put that machine out of business too. The trouble was all in the steam pipe, so

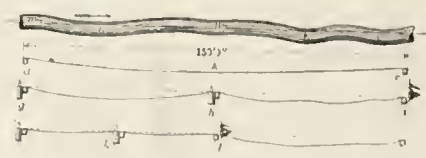


FIG. 2.—LINING A STEAM PIPE IN THE DARK

a line was run through the dark store rooms, alongside the pipe, as shown by Fig. 2. The line was first stretched "neck and heels" from each end, then the line was straightened. The pipe is shown in its

was moved exactly in line with *g* and *i*, as determined partly by sighting the candles *h* and *g*, and later by sighting more closely to the illuminated edges of the targets at those lights.

After target *h* was in position and fastened, the eye was transferred to that target as shown at *l*, the candle put alongside another target at *k*, and the three points, *j*, *k* and *l* brought into line as before. It was found that the pipe originally had a pitch toward the boiler. This was changed by adding a short nipple above the boiler, giving the pipe an inclination of 4½ in. toward the engine. The writer prefers this arrangement, as then there is always a steady flow of entrained water in the direction of the steam, whereas, with the drainage toward the boiler, the flow of

steam sometimes holds up the water until an extra rush of steam takes place, whereupon the water is brought over into the engine by the rush of steam. After the line had been supported and all the sag taken out of it, as shown at *n, m, o*, the condition of the pipe alignment was plainly discernible and steps were immediately taken to cure the trouble. It was not thought advisable to try to level the floor so as to bring the pipe straight. What was done consisted of placing enough posts along the line of pipe to prevent the floor from going down when loaded. Then means were taken to bring the pipe to the line and keep it there.

Pieces of 2-in. by 4-in. scantling were placed underneath the pipe, one at each pipe-hanger, then wedges were driven under the scantlings until the pipe was in place. There was no means of adjusting the old pipe hangers, except by pulling them out and driving them in again at the required height. This did not work at all well. In fact, it is a mighty good job to hang pipe upon the hangers shown by Fig. 1, and to have the pipe straight when the job is done.

The hangers were so firmly driven into the timbers that they could not be removed without breaking half of the hooks and without badly distorting most of the rods in the attempt to pull the hooks out of the timbers, that it was decided to let them remain and block up between the hangers and the pipe, until the latter was brought into alignment. All sorts of schemes were proposed by the management for shortening some of the hangers so that adjustment could be made, one member proposing that the hanger be cut off below the pipe and threaded as shown by Fig. 3, a yoke applied and the hanger-rods threaded below the yoke *d*, the adjustment being made by screwing the nuts up or down. Another member of the company wanted to cut the hanger above the pipe, remove one leg and let all the weight of the pipe come upon rod *c*, which was to be connected with the pipe by means of the yoke *f* and the U-rod *g*, which was to be made from the remainder of the original hanger and threaded as shown by the engraving Fig. 4. Still another wanted to apply an arrangement somewhat as represented by Fig. 5, in which the old hanger was cut off and the lower ends of the rods turned up as hooks, as shown at *a* and *b*. Chains were to be hung to each of the hooks, at *c* and *d*, and the ends of the chain brought around under the pipe and fastened by the old device known as the "toggle and fid." The pin doing duty as the "fid" is shown at *e*.

To secure adjustment to any height within reasonable limits it was suggested to use chains with links of different lengths, as represented by Fig. 6, at *a* and *b*, thus adjusting the height of the pipe in steps. The chain *a* has two links to 6 in., as shown, while chain *b* has a pair of links to each 6¼ in., making the links respectively 3 in. and 3½ in. long. Changing the length

of both sides of the hanger ¼ in. would therefore give a vertical adjustment of 1/16 in. in the height of the pipe. The writer suggested that the cost of thus changing the pipe hangers would cost much more than it would to put in entirely new hangers of an approved adjustable type similar to those shown by Figs. 7 and 8. The former shows two forms of hanger, style A being adapted to light pipes under 4 in. in diameter, while style B is fitted for heavy pipes of larger diameter.

Style A, Fig. 7, is made of malleable iron, the point *c* being threaded similar to a lag screw and screwing into the timber to which the pipe is to be attached; a length of small steam pipes, *b*, is cut and threaded to fit the drop of the hanger as found necessary. The screw point *a* has its lower end pipe-threaded to fit the coupling which connects the point *a* with pipe *b*. The clips *c* which encircle the pipe are usually made of malleable iron in two pieces, and they are bolted together and to the fitting into which pipe *b* is screwed. The hanger shown at B, Fig. 7, may be fitted either with the beam-clips *f* or the screw point *a*, as required. The vertical adjustment at A is made by varying the length of pipe *b* and by screwing point *a* farther into the timber. Besides the fixed adjustment in hanger *b*, by changing the lengths of rods *h* and *i* there is a turn-buckle *g* which permits the fine adjustment to be made with great exactness. The clamp clips *j* are similar to those shown at *e*, and they are attached to pipe *c* in the same manner as to pipe *d*.

A still better form of pipe hanger is shown by Fig. 8. This hanger is adjustable to any height or drop, by varying the length of bolts or rods *a, a*, which may be cut to any length and are adjustable at any time by means of the nuts supporting yoke *b*. The travel of the pipe, caused by the linear expansion, is taken care of by the little trolley wheel which runs upon yoke *b* and permits the pipe clamp to travel with the pipe instead of swinging as is necessary in all the other hangers described above, and thereby raising the pipe vertically more or less as the hangers move pendulumwise with the expansion and contraction of the steam pipe.

Thus far the owners had not succeeded in solving the problem of readjusting the old hangers to the pipe in its new position. The engineer then came forward with a sketch of a little casting, as shown at *d*, Fig. 9. This casting was made with a taper-curved cross section to fit both pipe and hanger. The little notches served to hold the ratchet wedge from moving endwise as the pipe expanded or contracted, yet it was possible to move the wedge endwise (by raising the pipe a trifle), thus securing the necessary vertical adjustment to pipe *c*, the old hanger a remaining unchanged as driven into beam *b*.

The above noted arrangement was the most sensible one proposed, but there was just one thing in the way of adopting it.

and that was it would require considerable time to make the pattern and obtain the necessary castings, one for each of the hangers. Again, as some of them would have to be blocked up 4 in., there would be quite a bill for iron by the time the job was done. The work was finally done by wedging the pipe up as noted, and temporarily blocking it. When there was over 1 in. between the hanger and the pipe, a piece of sheet iron, ¾ in. thick and 12 ins. long, was bent in a semi-circle to fit the hanger, as at *d*, Fig. 10, and placed in position as shown. The pipe was blocked on the thick sheet-iron by means of a brick or two, or an old bolt nut or a piece of scrap iron as happened to fit the space. Then the space between the shoe and the pipe was filled with cement mortar, which was well pointed in and left to set.

Where there was less than 1 in. adjustment—and the pipe was so located that none of the hangers had to be lowered—a bolt and yoke clamp was put across the hanger rods above the pipe as shown by Fig. 11, and screwed up until the pipe had been raised the required distance, as shown by Fig. 12, where the rods had been pulled almost together before the pipe had been raised the necessary amount. Having raised the pipe to the desired point, measure the distance between the clamp pieces, then have a double ended hook made with just the same distance between the hooks. Screw up the clamp bolts until the double hook can be slipped over both hanger rods, then remove the bolt and yoke clamp and drive the double hook into position as shown by Fig. 13, and the necessary adjustment is complete.

The pipe was very quickly hung up in this manner, and the cost was very slight. It is safe to say that the owners will never have another cylinder head blow out by water being stored in the steam pipe while the engine is running.

Some little trouble has been caused at Menominee, Wis., by the leakage into a sewer of tar from a local gas plant. The sewer was cleaned out by floating a light line from manhole to manhole. A larger rope was then pulled through the main by means of the light line and later a heavy rope. A large bucket was attached to the heavy rope and was drawn through the main by two teams of horses attached to the other end. The tar was thus swept down the main to the manholes, where it was removed.

The Empire Engineering Co., New York, was the only bidder July 21, for New York State Barge Canal Contracts Nos. 60 and 64. The bid for Contract No. 60, which is for work 8½ miles west of Rochester, N. Y., was \$1,319,081, and the bid for Contract No. 64, which calls for excavating between Medina and Gassport, a distance of 10 miles, was \$1,290,192. Both bids exceeded the engineer's estimates.

Variation in Weight of Stone.

BY HENRY F. ALEXANDER.*

Frequently we see tables printed in engineering and other papers and books giving the weight per cubic foot of various building materials. These tables of course include limestone, sandstone, etc.

The writer has never, however, seen such a table of weights that stated whether the stone in question was "green" or "well seasoned." Apparently very few people realize that there is any difference worthy of consideration between the weight per cubic foot of "green"—i. e., freshly quarried—stone and stone that is "well seasoned"—i. e., quarried and exposed to sun and weather for some time.

During the past five years the writer has inspected about 900,000 tons of limestone at the quarries on Johnson Island, O., and Kelly's Island, O. This stone was used in constructing government breakwaters at various Lake Erie ports, especially Cleveland and Ashtabula. The sizes of the stone used varied from what is known as pier stone, or small riprap, to blocks weighing about 16 tons.

This stone was shipped on scows and the tonnage was ascertained both at quarries and at the port where it was received. Frequently there was considerable difference between the tonnage at the quarry and tonnage at the receiving port. In nearly every case it was greater at the quarry. The writer made numerous experiments to try if possible to find some cause for this difference. The experiments were confined to small stone. Following are some of the experiments and their results:

(1) A "green" stone was taken from quarry and weighed. It was immersed in water for 6 minutes and again weighed. No difference in weight was shown. This same stone was exposed to sunshine and weather for 6 days and was then weighed and showed a loss of 9.7 per cent in weight. In a conversation later on result of this test, the quarry superintendent informed me that it was customary to allow 10 per cent for loss in weight for small stone when exposed to weather for a considerable time.

Experiment (2). A well seasoned rock was weighed and then immersed in water for 6 minutes and then weighed, showing a gain in weight of $3\frac{1}{4}$ per cent. One immersed in water for 6 hours showed a gain of $3\frac{1}{2}$ per cent in weight.

From the results of the above experiments and general observation, following are our conclusions:

(1) Stone when freshly quarried is generally fully saturated with moisture and will not absorb more. It rapidly parts with its moisture when exposed to sun and weather, and consequently decreases proportionately in weight.

(2) The smaller the stones the more rapidly do they part with their moisture and, vice versa, when well seasoned they

will absorb moisture much more rapidly when brought in contact with water.

(3) Large stones part with their moisture much more slowly and consequently when exposed to sun and weather for a short time there will not be so much difference in weight.

The general conclusion is that in buying stone by the ton due consideration should be given to the question whether the stone is freshly quarried or well seasoned, as on this point may depend much of the profits of a contract.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0827. **Reinforced Concrete Buildings.** The Ferro-Concrete Construction Co., Cincinnati, O.

* This 16-page pamphlet illustrates and describes briefly a number of reinforced concrete buildings constructed by the company named.

No. 0828. **Universal Portland Cement.** Universal Portland Cement Co., Chicago, Ill.

This bulletin illustrates and describes a number of interesting structures in which the above brand of cement has been used and gives a full and instructive account of methods of concrete track construction employed on certain Chicago street railways.

No. 0829. **Koppel Cars.** Arthur Koppel Co., Pittsburg, Pa.

This pamphlet describes the above company's V-shaped steel dump cars and illustrates their use on various jobs of earth and concrete work.

No. 0830. **Pumps and Condensers.**—Buffalo Steam Pump Co., Buffalo, N. Y.

The 20 pages of this small catalogue are devoted to descriptions of pumps, manufactured by this company, including various types of steam and electric pumps and condensers.

No. 0831. **Centrifugal Pumps.**—Buffalo Forge Co., Buffalo, N. Y.

This is a 24-page catalog given over to a description of centrifugal pumps and various other kinds of pumps for use for many purposes.

No. 0832. **Scraper Excavator.**—H. Channon Company, Chicago, Ill.

A 32-page 8x10-in. catalog describing the Channon scraper excavator. This machine consists of a derrick house that revolves on a turntable like a locomotive crane, and is skidded along the ground on runways or rollers. The derrick has a long boom upon which is operated the power scraper. The scraper loads itself by being pulled along the ground and automatically dumps by releasing the pulling line. The catalog illustrates the use of the machine for many kinds of excavation work. This machine is now being used by a large number of contractors.

No. 0833. **Valves.**—The D. T. Williams Valve Co., Cincinnati, O.

This 180-page catalog is called by the manufacturer "The Blue Book." It is a very complete catalog, with a good index, well printed, of valves. A number of pages are devoted to the care of valves, and the packing and grinding of valves. There are descriptions and illustrations of brass and iron valves, steam cocks, boiler fittings, lubricators, oil cups, grease cups, steam traps and separators. This is a very useful catalog for all of those interested in steam appliances.

No. 0834. **Dump Wagons.**—Michigan Wagon & Mfg. Co., St. Johns, Mich.

An 8-page catalog describing the Michigan dump wagon, and showing by illustra-

tions, the various sizes of wagons made by this company and the characteristic features that go to make it, according to the claims of the manufacturers, one of the best wagons on the market. This company makes an asphalt dump wagon lined with asbestos and steel.

No. 0835. **Scrapers and Plows.**—American Steel Scraper Co., Sidney, Ohio.

This is a 44-page catalog devoted to earth moving tools, made by this company, consisting of drag scrapers, tongue and board scrapers, wheel scraper, brick scrapers, railroad and township wood plows and wheelbarrows. A well gotten up catalog.

Personals.

Harris, Craven & Von Borries, engineers and contractors, have opened offices in the Paul Jones Bldg., Louisville, Ky., and will engage in general engineering and construction work.

Mr. T. H. Brown, has been appointed Assistant Engineer of the Philadelphia Division of the Baltimore & Ohio R. R., succeeding Mr. G. T. Warren, who has been made a Supervisor.

Mr. H. A. Paine has been appointed Road Engineer of Caroline County, Md., succeeding Mr. W. D. Uhler, who has accepted a position as Assistant Engineer of the Maryland Good Roads Commission.

Mr. L. Beckham, formerly in the Track Department of the Denver & Rio Grande R. R., has been appointed Superintendent of Construction of the Cheyenne Electric Street Ry. Co., which is now constructing a street railway at Cheyenne, Wyo.

The Mack Construction Co., of Philadelphia, which has the contract for the construction of the Bronx Valley sewer, New York City, which is to cost \$2,250,000, has appointed Mr. Freeman H. Merritt, of White Plains, N. Y., General Manager over the entire work, with the exception of the tunnel section under the City of Yonkers. Mr. Merritt will take charge at once.

Mr. Kenneth Allen has resigned his position as Division Engineer of the Sewerage Commission of Baltimore, Md., and will become Chief Engineer of the Metropolitan Sewerage Commission of New York. Mr. Allen has had charge of the Low-Level Division of the Baltimore Sewerage Work. This Division will now be combined with the Storm Water Division and Mr. Herbert M. Knight will have charge of both Divisions.

Daniel N. Stanton, a former contractor, died July 17 at his home in New York City. Mr. Stanton was born in Bartlett, N. H., 51 years ago, and entered the railroad construction business at the age of 16, when the Boston, Concord & Montreal R. R. was being built. He was successively engaged in the construction of sections of the Grand Trunk, the Boston, Hartford & Erie, the Portland & Ogdensburg, the Illinois Southern, the Delaware, Lackawanna & Western, and the Erie R. R.

The construction work on the Isthmian Canal is now being carried on in three divisions: The Atlantic Division, embracing all territory north of Tabernilla, division engineer, Maj. William L. Sibert, headquarters Gatun; the Central Division, embracing all territory north of Pedro Miguel to and including Tabernilla, and including the dump grounds in the Pedro Miguel District, division engineer Maj. D. D. Gaillard, headquarters Empire; and the Pacific Division, embracing all territory south of and including Pedro Miguel, except the dump grounds of the Central Division located in this territory, acting division engineer, S. B. Williamson, headquarters Corozal. The Central Division has been divided into six construction districts, as follows: Pedro Miguel District.—Extending from Panama railroad bridge over the Canal at Paraiso, south to Pedro Miguel locks, Pedro Miguel yards, Miraflores dump and La Boca dump. W. T. Reynolds, Superintendent of Construction; headquarters transferred from La Boca to Pedro Miguel. Culebra District.—Extending from south end of Culebra "Y" south to Paraiso bridge. Joseph Little, Superintendent of Construction; headquarters, Culebra, Empire District.—Extending from south end of White House yard to south end of Culebra "Y." D. E. Crowley, Superintendent of Construction; headquarters, Empire. Bas Obispo District.—Extending from Chagres river to south end of White House yard. J. W. Sneed, Superintendent of Construction; headquarters transferred from Bas Obispo to Las Cascades. Gorgona District.—Extending from Mamel south to the Chagres river. W. G. Shea, Superintendent of Construction; headquarters, Gorgona. Tabernilla District.—Extending from Tabernilla south to Mamel. G. A. Greenslade, Superintendent of Construction; headquarters transferred from Tabernilla to San Pablo.

*U. S. Inspector of Rock, Kelly's Island, O.

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Practical Suggestions for Railway Location Surveys.

The article on methods and cost of mountain railway location which we publish in another column deserves being read by every railway locating engineer. It is not only full of valuable suggestions but it is written in a most entertaining style. There is almost no end to the number and the variety of the articles and books that have been written on the subject of railway location surveys, but it remains a subject of never-ending interest. To our mind this results from two principle causes. The surveying problems proper to be solved are never exactly alike in any two cases, and the work of the engineer is quite as much executive and managerial as it is technical.

The good locating engineer is not only a man who can lay down the best line from a railroad engineering point of view but a man who can organize a corps of assistants and manage them so as to get the best possible results in the way of productive work. This involves so housing and feeding his men, and caring for their health, that their best energies are always available. In fact it involves a thousand and one details that no one but an experienced locating engineer can fully realize and of which our engineering schools and their summer camps for surveying scarcely give a suggestion.

It is because of his practical talk on these un-technical matters, if we may use the term, that Mr. Cryderman, whose article we publish, deserves listeners. We have read many articles on locating surveys which were more replete with tables and formulas than is this one, but we have read very few which give so much sound instruction regarding the personal element in the locating surveyor's work.

Tables and formulas can be had in any one of a dozen pocket books, but there are not more than one or two books, and these are mentioned by Mr. Cryderman, which give the every-day camp and cook tent data that keep the men fit to handle the tables and formula. These untechnical data make up a good part of Mr. Cryderman's paper, and the technical data which constitute the remainder are of the common (sense) or garden variety which keep the van wagon moving but show up small on the plotted map. To us these facts have made the article which we reprint of intense interest and we believe that many of our engineer readers will peruse it with the same feelings.

The Bleeding Method of Unwatering Trench Excavations.

We give space in this issue to a description of a very successful application of the bleeding method of unwatering water soaked soil in excavating a large sewer trench. The material in this particular case was water soaked, fine sand, practically a quicksand, ordinarily impossible of ex-

cavation without sheet piling and unusually elaborate timbering. By bleeding the sand to a level somewhat below subgrade by means of ordinary well points water troubles were practically eliminated and the sheeting problem was reduced to very simple proportions.

This piece of work has been of unusual interest to the editors of Engineering Contracting for the reason that it follows substantially a suggestion made by one of the editors some two years ago. In our issue of Aug. 15, 1906, in describing the work of unwatering a filter bed excavation by the bleeding method, the following statement was made:

"There is no doubt that many wet trenches dug in sandy soil could be kept dry with pump points. The points could be driven in a long row; and, as the digging progressed, additional points could be driven and connected with the suction pipe. As back filling takes place the points can be taken up and a plug or cup put on the end of the pipe, and the point moved ahead. From time to time the pump and boiler would have to be moved, but this could be provided for by mounting them on wheels."

From the description of the trench work which we give elsewhere it will be observed that not only is our prophecy of success borne out, but the very methods which we outlined are being substantially followed. This is gratifying chiefly for the fact that it confirms our belief expressed two years ago that the bleeding method has a wide field of adaptability in excavation work. The method is not necessarily confined to the kinds of work we have described, but will serve equally well for drying railway cuts, reservoir sites, foundation pits, etc.

With the exception of the cost data given in our issue of Aug. 15, 1906, the cost of unwatering sand by well points given in another column is perhaps the only example available in print. In the work described two years ago the cost of pumping added about 100 per cent to the cost of excavation. The figures given in this issue are not so definite, but they make it reasonably certain that the above percentage of increase was not exceeded and probably was not reached. Altogether the data which we have given on the bleeding method indicate that it is one which contractors can adopt with profit on a variety of occasions.

The Superintendent of Public Works of New York State has awarded contracts Nos. 60 and 64, Barge Canal work, to the Empire Engineering Co., New York City. The contracts amount to \$2,639,576.

The Board of Water Supply of New York City has awarded the contract for constructing a $6\frac{1}{2}$ -mile section of the Catskill aqueduct, including the Peak tunnel, to the Stewart-Kerbaugh-Shanley Co., New York City. The contract price was \$2,368,820.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Some Methods Employed in Constructing the 7½-Mile Reinforced Concrete Aqueduct for the Water Supply of Salt Lake City.

The Big Cottonwood Conduit, 38,667 ft. or 7.32 miles long, recently constructed for the additional water supply of Salt Lake City, Utah, is one of the largest reinforced concrete aqueducts ever built. This aqueduct extends from a reservoir and head works at the mouth of the canyon of Big Cottonwood creek and runs chiefly along side hill to a connection with an older aqueduct at Parley's Creek Canyon. This connection is made by a special 180-ft. drop which is described further along.

The aqueduct is shown in cross-section for various parts of the work by the draw-

the work already done, certain changes in design were made and it was thought de-

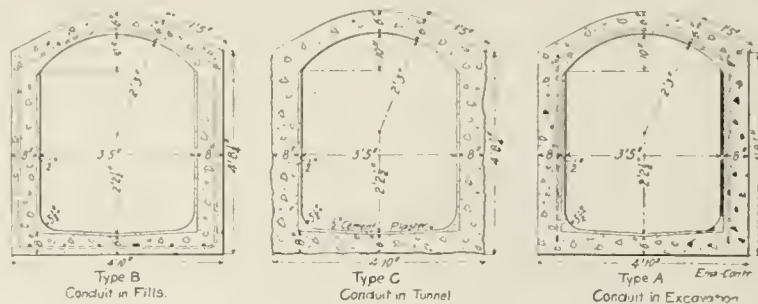


Fig. 2—Sections of Conduit for Various Types of Construction.

sirable that the whole of the cross section be cast or formed at one time. The drawings of Figs. 1 and 2 show the varied de-

intention at some future time to divert a portion of the water at the head of this drop through a pressure pipe for the higher portion of the city. Incidentally it may be noted that the main aqueduct will ultimately be extended 4½ miles above its present upper end to another stream.

The conduit is lined with cement mortar ½ in. thick, and has a capacity of 50 second feet. It is provided with three 12-in. safety blow outs, and a 24-in. wooden stave by-pass at the connection with Parley's Canyon Conduit to be used in case it is undesirable to have the water pass through the reservoir. The weirs at the intake of the dam are adjustable Cippolitti weirs having a total length of 30 ft. with a depth of 3 ft.

The conduit was constructed by setting up the mixer about every 1,000 ft. and

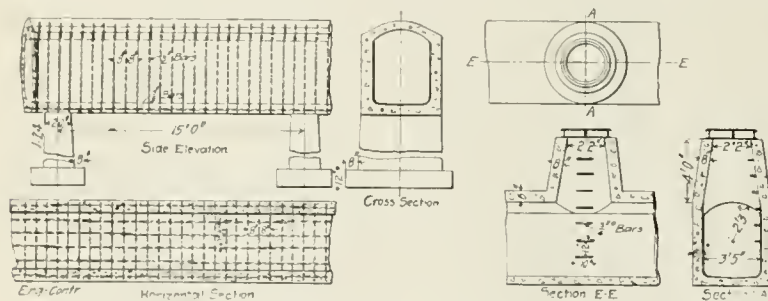


Fig. 1—General Plan of Conduit on Piers and Details of Manhole Construction.

ings of Figs. 1 and 2. Originally the design was somewhat different, in the respects that the top was much flatter and the walls thinner, and the specifications for construction read as follows:

"In constructing section 'A' of conduit, the sides up to the bottom of the roof shall be built first. After the forms have been removed, the bottom shall be placed, the upper surface of which is to be tooled to leave a smooth, even surface. Four days more must elapse before the work of placing the roof is started.

"In constructing section 'B' of conduit, the bottom, sides, and top shall be built in one continuous operation which shall also complete a 15-ft. length. No joint in section 'B' between new concrete and that already set will be permitted except the vertical ones at the piers."

As a matter of fact, even that part of the conduit constructed in 1895, some 1,050 ft., was not constructed according to these specifications, but the sides and bottom were of monolithic construction, and the roof was afterward attached to the walls.

In the spring of 1906, after inspection of

signs. These drawings are self-explanatory, about the only thing to be noted being that for type B conduit the piers were

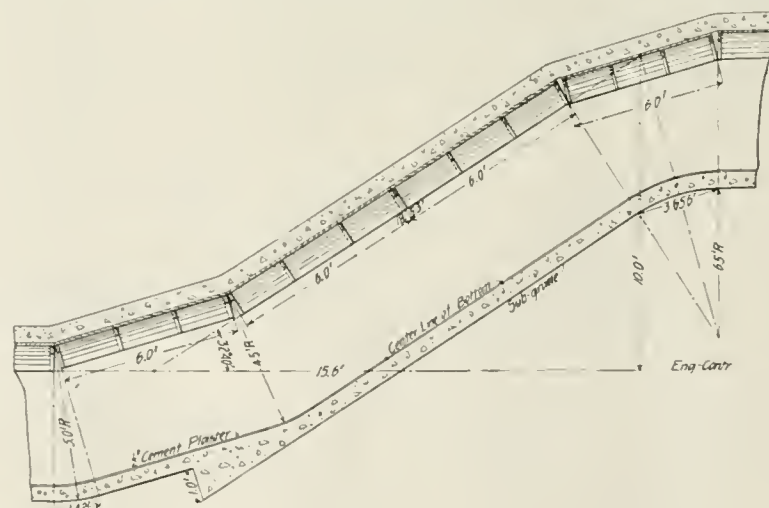


Fig. 3—Section of Drop Connection at Parley's Creek Canyon.

built in advance of the aqueduct proper in order to obtain a true joint for expansion between pier top and aqueduct bottom. The

working both ways from it. Figure 4 shows a typical mixer set-up. The concrete car track runs under and in both di-

rections from the mixer, being carried on stringers laid on caps supported by the posts of the outside forms. A Smith mixer was used.

Owing to the character of the soil, which was a coarse loose gravel in some places and a cemented gravel in others, it was necessary to use outside as well as inside forms, Fig. 5. All forms were of pine lumber dressed. The outside posts were 4x6 ins.; caps 4x6 ins.; sheeting 1x12 ins., with two 1-in. ribs, and one 2-in. rib in center; inside forms, posts 2x4 ins.; sheeting 1x4-in. flooring; braces 2x4 ins.; roof forms, ribs 2-in. lumber; sheeting 1x4-in. flooring. The panels were 6 ft. in length. The car track was laid on stringers bolted to caps. The caps were fastened to the posts with loose ½-in. iron bolts and the suspension pins were ½-in.; corner braces were 2x½-in. iron.

The two sections of the roof forms, Fig. 6, should be turned back against the sides, leaving the form open. The inside forms

en to build the extreme points first to avoid traffic over the finished concrete.

The form work was in charge of a foreman who had the knack of that particular

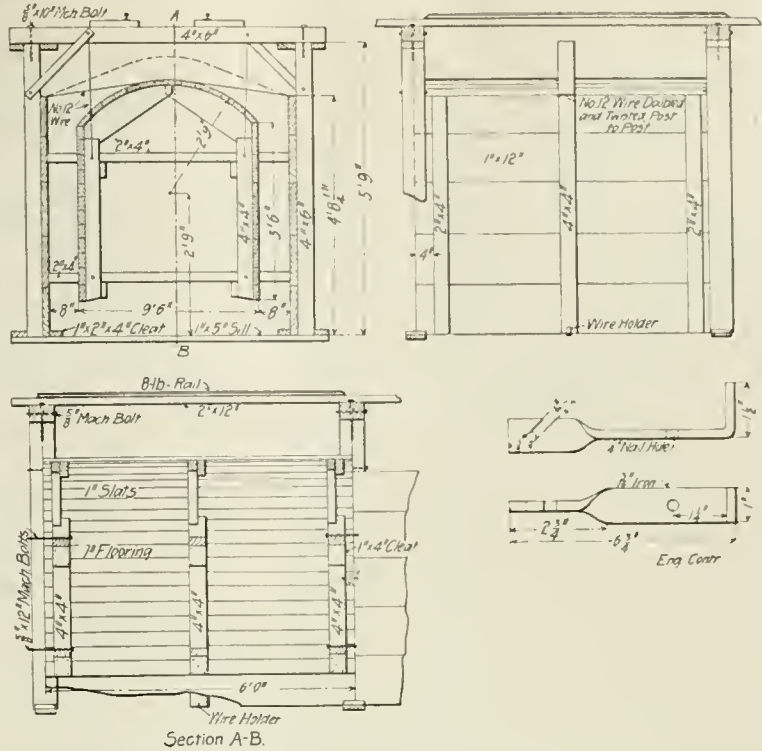


Fig. 5—Standard Forms for Conduit Construction.

As it was impossible to build the upper end of the conduit until after the greater

class of work, nearly all material used in special design being readily taken apart and



Fig. 4—View of Typical Mixing Plant and Car Track Construction.

were suspended with common bailing wire hangers which were cut when forms were removed.

The running boards were on the outside of the car tracks, leaving the space between tracks open for dumping. Loose boards were sometimes placed between tracks for convenience. The clearance below the edges of the inside forms was sufficient to allow the forming of the invert with a trowel and float.

The work of transporting the forms from point of removal to point of resetting was performed by a force of 16 men. These men were able to remove and reset approximately 400 ft. per day. The forms were transported by wagons in varying numbers over the rougher parts of the work; the transportation was extremely difficult.

The construction proceeded at the rate of from 275 to 400 lin. ft. per day, the mixer being set approximately at each 1,000 ft., the cars working both ways. Care was tak-



Fig. 6—View Showing Material Track and Forms in Place.

portion of the whole work was finished, water was carried in 2-in. pipes from several springs along the line of the work.

usable in other work. The principle was to fasten strongly such parts as it was necessary to fasten, and to make the remain-

der of the form dependent on the former for support; cleats, bolts, and wire were given preference to nails or screws.

The location of the conduit along the west slope of the mountains rendered the transportation of materials very costly and difficult, it being necessary to construct approximately four miles of roadway along the face of the slope, and it was with much difficulty that this road was constructed with sufficient width for the passing of teams.

The materials for construction were obtained along the line of the work, fairly good sand and gravel being obtained at several points. It was necessary, however, to carefully screen all these materials and inspect the sand pits carefully during the excavating on account of small deposits of earth.

The cost of the conduit was as follows:

Contract work.....	\$386,740.37
Extra materials.....	22,542.46
Right of way.....	4,581.65
Engineering	23,312.48
Inspection	4,595.96
Advertising	203.88

Total\$441,976.80

The distribution of materials was as follows for conduit, dam and lining reservoir at outlet:

Portland cement concrete, 16,845.47 cu. yds.

Brick masonry, 126.71 cu. yds.

Steel reinforcement, 398,542 lbs.

Fabricated metal, 34,895 lbs.

Stone rip-rap, 855 sq. yds.

21-in. wire wound wooden stave pipe, 952 lin. ft.

Excavation earth, 53,753 cu. yds.

Excavation rock, 4,990 cu. yds.

Tunnels in earth, 1,700 lin. ft.

Tunnels in rock, 360 lin. ft.

The contract work was performed by P. J. Moran of Salt Lake City, the direct supervision being under his superintendent, Mr. Frank B. Gawan. Much is due to Mr. Gawan for the untiring supervision of every detail of the construction, it being in a great measure due to his careful work that the work of construction was performed without serious accident or labor trouble. The entire construction was practically under the office of the City Engineer, Mr. L. C. Kelsey, he being at all times represented on the ground by an assistant, the general supervision being under the principal assistant engineer. Inspectors were furnished by the Board of Public Works.

The grand total of excavation on the Isthmian canal during the month of June was 3,060,307 cu. yds., all of which except 165,316 cu. yds. was taken from the canal prism. Of the grand total 1,828,538 cu. yds. were taken out by steam shovels and 1,229,370 by dredges. There were 26 working days and the mean rain fall for the month was 10 ins.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Methods and Cost of Earth and Rock Excavation for a Railroad Cut.

In keeping cost records for excavation it is an easy matter to arrive at the cost of moving solid rock and earth if all the material to be moved in a cut is either one or the other, but, as frequently happens, a single cut will have solid ledges of rock, large and small boulders, and earth on top of all of this rock.

The unit costs of earth and rock derived from the cost records under those conditions are not actual costs, but depend upon the classification allowed by the engineers.

This statement does not apply to earth and rock cuts that are first stripped of earth, but to such cuts as are blasted from the top and the earth and rock handled at one time, as is nearly always done in mountain railroad building. In considering cost data of excavation, other than earth, these facts must be kept in mind:

The work to be described in this article was a heavy cut about 25 ft. deep on the line of a new railroad that was built a few years ago in West Virginia. The cut was a through cut, being a little higher on one side than on the other. The earth was a stiff, red clay, mixed with disintegrated sandstone, and the rock was a red sandstone that dulled a drill and made a large amount of sludge, but not as much as a shale rock makes.

The specifications were very fair, classifying the sandstone as solid rock, disintegrated sandstone as loose rock, and the clay as earth. The classification put on the cut by the engineers was earth 31 per cent, loose rock 25 per cent and solid rock 44 per cent. This classification being made from levels and measurements taken in the field.

A 10 hour day was worked with Austrian laborers who received \$1.50 per day. Negro drivers were used and were paid \$1.25. The contractor owned his own mules, and two mules and two carts were used in the cut, one driver attending to the two. While one cart was being loaded the driver took the other to the dump and returned. It cost about 60 cents per day to feed and care for a mule and \$1 a day was charged for a mule, a cart and the necessary harness. This was ample to cover the expense of the horse and depreciation and interest on the outfit. This made a total charge for teams of \$3.25 per day. The wages paid the foreman varied, being an average of \$2.10 per day. When the work was commenced capable foremen were scarce, and a fair foreman

was employed for \$2 per day. He made money on the work, but he was replaced by a better man at \$3 per day, and this man was finally replaced with a foreman whose rate was \$3.50 per day. The record of cost each day showed an improvement under each of these new foremen, thus illustrating that a high-priced foreman is the man to employ. It is evident from this that if a good foreman could have been obtained at the start, the costs to be given would have been reduced somewhat.

Dynamite (40%) cost 10 cts. per lb., black powder cost \$1.10 per keg of 25 lbs. Double tape fuse cost 12 cts. per 100 ft., caps cost 60 cts. per 100 and electrical exploders cost from 4 to 7 cts. each.

The gang working in the cut consisted of 10 men, including the driver, but exclusive of the foreman. Eight men worked in the cut, three men always shoveling, the rest doing the picking, drilling and boulder breaking. One man attended to the dump. This man, by means of a tally board, kept a record of the cartloads of material delivered to the dump. The number of loads delivered in a month, divided into the yardage given in the engineers' estimate, showed that the average load carried by a cart was $\frac{1}{2}$ cu. yd. It must be remembered that these loads consisted of solid rock, loose rock and earth, hence the average load would be much larger than when rock alone is being handled. The carts were used without tail gates. For records showing the capacity of dump carts when hauling rock, see Gillette's Rock Excavation—Methods and Cost," pp. 180 and 226.

Keeping a tally of loads is an excellent incentive to spur men to rivalry on excavation work. Such records should be posted each day where the men can see them, and comments made upon the work done by the various crews. Such records also give a ready check on the yardage moved and show whether or not the work is being handled to advantage.

The drilling for blasting was done by hand with long churn drills. These are made by welding a piece of tool steel about 18 ins. long to a long piece of bar iron or to a section of 1½-in. pipe. In this case the top of the cut being earth and loose rock, the drilling with a churn drill was done quickly until the solid rock was reached, when a 15 to 25-ft. drill was used, giving enough weight to carry the bit through the harder rock at a good rate. In blasting, two holes were drilled abreast in the cut, each being just inside of the toe of the slope. These holes were sunk

by three men 1 ft. below the profile grade, and were sprung with dynamite. The holes were shot with black powder, the charge not being heavy enough to throw material outside the cut. The contractor exercised great care in this, as the specifications provided that all material wasted in this manner by the contractor should not be paid for by the railroad company and this provision was rigidly enforced. The two holes were shot simultaneously with electrical fuses and a battery.

Boulders and large rocks were drilled for the most part with hand drills and shot with dynamite and fuse. Some of the boulders were "undermined," while some were "mud capped," but both of these methods are more expensive than "block holing." See "Gillette's Rock Excavation—Methods and Cost," pp. 232 to 236.

The amount of explosives used in blasting the cut and breaking up the boulders averaged $\frac{1}{2}$ lb. to each cubic yard of material. This was made up of 0.4 lb. of black powder and 0.1 lb. of dynamite. The solid rock was the only material that had to be broken up after it was blasted, to be handled, and this took on an average of 0.3 lb. for each cubic yard of solid rock.

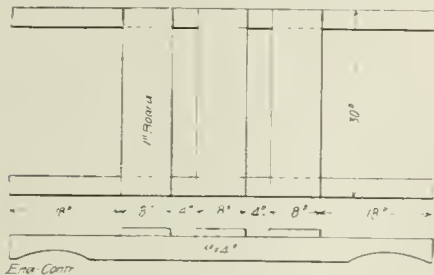


Fig. 1—"Devil" for Handling Boulders

The writer believed this could have been reduced by using Judson powder for blasting the cut, instead of black powder. The Judson powder would have pulverized and broken up the ledge of sandstone much better than the black powder did.

Some of the boulders were broken up by sledge hammers. To assist in this work several "gads" were used. A gad is a wedge-shaped piece of steel that is driven into a rift or seam of a rock to split it. A gad can save much time in sledging stone. A little water thrown on the stone will assist in the gad taking hold better when it is being hit.

Another device that saved money in handling the boulders was a "devil," see Fig. 1. It consisted of several boards 1x8 ins., nailed to two 3x4 in. scantlings or round poles. This is placed on the ground and a boulder a cubic yard or less is rolled on to the devil. Then the crew of men take hold of the handles and lift it high enough to dump the boulder into the cart. This is done to better advantage when the crew is just beginning to load the cart.

The work was done in the winter and

early spring. The cost per cubic yard was as follows:

Earth.	Per cu. yd.
Foreman	\$0.016
Laborers	0.971
Dumping	0.009
Carts and driver.....	0.020
Explosives	0.014

Total	\$0.130
Loose rock.	Per cu. yd.
Foreman	\$0.031
Laborers	0.112
Dumping	0.017
Carts and driver.....	0.038
Explosives	0.028

Total	\$0.256
Solid rock.	Per cu. yd.
Foreman	\$0.053
Laborers	0.243
Dumping	0.030
Carts and driver.....	0.066
Explosives	0.048

Total	\$0.110
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It will be noticed that these costs do not include superintendence, blacksmithing and general expense. These costs will ordinarily average not over 2 cts. per cubic yard when 100 men or more are being worked on a contract. The cost of employees' liability insurance on this work was not quite $\frac{1}{3}$ cts. per cubic yard.

To illustrate the method used in deriving the above given costs, let us take an example. Suppose the bidding prices are 15 cts. per cubic yard for earth, 30 cts. for loose rock and 57 cts. for solid rock. Suppose the engineer's monthly estimate gives the contractor \$2,500, while the contractor's records show an actual cost of \$2,000. The total actual cost was, therefore, 80% of the amount received. Hence 80% of 15 cts. gives 12 cts. as the actual cost of the earth per cubic yard. Likewise, 80% of 30 cts. gives 24 cts. as the actual cost of the loose rock. As above stated, it is clear that this method does not give true actual costs unless the engineer's classification is perfect and unless the contractor's bidding prices are perfectly balanced.

Some Interesting Records of Excavation at Panama and on the Erie Canal.

This journal has published from time to time weekly, monthly and yearly records of excavation done on the Panama Canal. Such records are of interest to engineers and contractors. For the fiscal year ending June 30, 1908, 27,979,382 cu. yds. of earth and rock were excavated at Panama; of this amount 17,467,168 cu. yds. were excavated by the steam shovels, the rest being done by dredges. From the Culebra Cut 12,005,360 cu. yds. were excavated. Work commenced on the Panama Canal during the first half of the year 1904, and this year's work surpasses any other in amount of material handled, being 66 per

cent of the total amount of excavation—namely: 10,938,575.

During the month of June, 1908, there was an average of 10 ins. of rainfall, and the excavation handled during the month was 3,060,307 cu. yds. The highest dry season monthly record was for March, 1908, when 3,180,270 cu. yds. were excavated.

There are now on the isthmus 101 steam shovels of two makes and three sizes of each make—namely, 45 ton shovels with $1\frac{3}{4}$ cu. yd. dipper, 70 ton shovels with $2\frac{1}{2}$ cu. yd. dipper and 95 ton shovel with a 5 cu. yd. dipper. There are also ten dredges, there being some ladder dredges, some dipper dredges, some hydraulic dredges pumping through a pipe line and two self containing sea going dredges. Naturally some of this outfit is undergoing repairs at all times, and is out of commission at times for other reasons. Thus in the month of June, 1908, the average number of steam shovels worked was 70.63. For that month the average output per shovel per day was 991 cu. yds., while the average output per shovel per month was 25,768 cu. yds. The working day is eight hours, and only one shift per day is worked.

During June, 1908, the amount of material excavated on the 1,000 Ton Barge Canal being built by the state of New York largely exceeded any previous month's record, being 1,112,529 cu. yds. Construction on this canal commenced about the middle of 1905, and all the contracts for the canal are not yet let, there being but 25 contracts now under way, with a large number still to be advertised. Thus work on the Panama Canal was started a year previous to that on the Barge Canal. In June, 1907, there was excavated at Panama 962,199 cu. yds. The largest month's record on the Panama Canal up to June, 1907, was in April, 1907, when 1,159,486 cu. yds. were excavated.

These figures allow of some comparison being made of the relative amount of work being done on these two important canals, three years after commencing work. It is true that the local conditions surrounding the two jobs differ exceedingly, but in both cases the vast majority of the excavation is being done with machinery that does not tire under a torrid sun nor refuse to work in a temperate zone, where the thermometer frequently goes to zero during the winter.

There are now at work on the Barge Canal not over 40 excavating machines, most of which are working but one shift, an eight hour day being the law, but some work two shifts and a few work three shifts each day.

These 40 machines consist of steam shovels, dredges of various types, power scrapers, such as the Page, Lidgerwood and Channon, a Lubecker excavator, several electric excavators, a Lobnitz rock breaker, and some special excavators with orange peel or clam shell buckets. Besides these a few elevating graders and some

scrapers are worked. The average number of steam shovels worked during the fiscal year 1906-7 at Panama was 29, and 5 dredges were worked during the same period. However, during that year there was an average of 50 shovels on the isthmus that could have been worked.

Up to date most of the work done at Panama has been that of excavation, while on the Barge Canal one-third of all payments made has been for the building of structures. Thus the total work done would be 50 per cent more than that shown in the excavation.

The Cost of Excavating a Culvert Foundation, with Comments on the Methods of Paying for It.

In railroad and wagon road construction a very common class of work to be done is the excavation for masonry and pipe culverts. This excavating is generally done by a foreman with a small gang of men, the earth excavated being, as a rule, thrown on each side of the culvert. When this dirt has to be moved, as it must be in some cases, it is spread out in the embankment under which the culvert is to be built, by means of drag scrapers. This spreading of the earth is sometimes considered extra work.

Some railroads pay for culvert excavation the same rates as apply to earth excavation in the cuts. Even when the excavation is dry, this is not altogether a fair basis, as the digging of ditches and trenches and culvert foundations has generally to be done by means of picks and shovels, while the earth in cuts is excavated by means of scrapers or tools that do it much cheaper than it can be done by hand. A special price should be named for each work. It is true that such items of work are generally an insignificant part of a large contract, but there is no reason why every class of work should not be paid for on such a basis as to admit of each class being done at such prices as will pay for its cost, instead of making one class of work carry another.

When the excavation for culverts is wet, the price paid for ordinary excavation will not cover it. Of course such excavation will not be as expensive as excavation under water for deeper foundations, yet it will be several times more expensive than ordinary excavation in the cuts, and also more costly to make than dry excavation for a culvert.

Culvert excavation should be a separate class of work and should be provided for in the specification under two items—namely: dry excavation and wet excavation. Without this being done, more or less of a hardship is put upon the contractor, in spite of the fact that he can name a price on ordinary excavation that will in the end net him a profit on the culvert excavation. The cause of the hardship lies in the fact that culvert excavation is done at the start of the contract, when the contractor is called

upon to expend large sums to install his plant and get under way. It is a hardship then to require the contractor to do a class of work in which there is no immediate profit.

The job to be described was done by one of the editors of this journal. The culvert was a 3x1 box masonry culvert, the excavation being 40 ft. long and 9 ft. wide, and averaged 1 ft. in depth. The material was sandy gravel and stiff clay. The stream was a small one and was easily diverted to one side, but, owing to the top soil being sandy gravel, the water percolated into the foundation as fast as it was dug. However, it was not necessary to pump it out, as a small trench, cut at the lower end of the foundation pit, carried off the water, care being taken in carrying on the excavation to do it so that the pit drained itself by means of this trench. However, this water made the clay wet and heavy and much more expensive to handle.

The crew that did the work consisted of a foreman and 4 men, who finished the job in one day. This gave a cost as follows:

1 foreman at \$2.50.....	\$2.50
4 laborers at \$1.50.....	6.00
Total	\$8.50

The charge for the tools used, 4 picks, 4 shovels and a mattock, would be so small that it can be ignored. There were 13½ cu. yds. of material excavated, which gave a unit cost of the following:

Foreman	\$0.19
Laborers	0.45
Total	\$0.64

This shows how large a proportion of the cost the foreman charge can be, where the gang is necessarily small. In this case supervision was nearly 33 per cent of the total cost. Each workman in 10 hrs. excavated 3½ cu. yds. This meant that he loosened and shoveled it. With the material dry and in a bank it would have been possible for a man to have done at least 10 to 12 cu. yds. in a day, thus showing that prices paid for ordinary excavation would not cover the cost of this wet excavation. We shall give other examples of this kind in some future issues.

The use of small reeds as a substitute for plastering laths is common in Germany and in other parts of Europe. The reeds used in this industry are chiefly imported from Hungary, and vary in length from 1 to 2½ yds. or even more, and from ¾ to 1½ ins. in diameter. By means of machinery these reeds are fastened together by wires so as to form a continuous mat as wide as the reeds are long, and which is cut with shears and fastened to walls or ceilings in place of laths. In some cases builders require the matting to be put on double, the aim in this case being to have the reeds in the upper mat fall at the interstices in the lower mat. The reeds are usually about ½ in. and the connecting wires about 8 ins. apart.

Methods and Cost of Earth and Rock Excavation with a Steam Shovel and the Cost of Repairing a Wrecked Steam Shovel.

The following record of steam shovel work done under one of the editors of this journal will be found interesting for several reasons. First, it is neither a remarkably cheap record of excavation nor is it an expensive one, the output of the shovel under the conditions being fair. Second, an accident occurred to the shovel that delayed the work, naturally adding to the cost.

The work was done in the south several years ago, on the excavation of a railroad, and comprises the record of two months' worked during the fall of the year, when the weather conditions were fairly good, there being only occasional rain storms. However, the month preceding had been exceedingly wet, there being frequent thunder storms and a number of days of steady downpour, making the ground very wet, this being the cause of the accident that occurred.

Description of Work.—The work done consisted of widening one side of a cut, the average height of the excavation being about 40 ft. The water in the side ditch of the cut was turned by boxes under the track into the ditch on the other side, making the work dry. The extra width given to the cut varied from 17 to 21 ft., and this distance would not allow of the regular jack arms being used on the shovel at all times. When this was not possible a special short jack arm was used on one side of the shovel, giving 2 ft. additional clearance. Short jack arms are valuable for such purposes, but the stability of the shovel is greatly reduced by their use.

The railroad company operated its trains through the cut while the work was going on. In all there were about 30 trains a day being operated on one track. Four of these trains were for passenger service and two were carded freights. These six trains had to be cleared by the contractor's dirt trains, ten minutes on their running time, as furnished by the telegraph operator, kept in the contractor's camp by the railroad company. The rest of the trains were cleared as they approached or else flagged until the dirt trains could take a side track.

The contractor's outfit was a standard gage one, and the main line of the railroad was used as a loading track and for hauling the material. The excavated material was hauled two ways to the dumps. One haul averaged a mile and the trains were dumped from the main line, the material being used to widen a long embankment. The average haul to the other dump was 2 miles, and the material was dumped from a temporary trestle, being used to make a new embankment alongside of an old one. Half the material excavated went to each dump, as the time saved in dumping from the trestle compensated for the extra distance hauled.

The material excavated was a red clay mixed with mica and this clay could be classed as "average earth." See Gillette's "Earthwork and Its Cost," page 22. In the two months 29,800 cu. yds. of this clay were excavated, and 1,200 cu. yds. of solid granite. The granite was in the bottom of the cut, over an area about 200 ft. long. Encountering this rock and having to take it out to grade retarded the progress of the shovel, as during the time the shovel was working in the rock the record of cars loaded each day was not over one-third as large as when working in earth above. The side of the cut was excavated to a $\frac{1}{4}$ to 1 slope, with the result that several cave-ins occurred. Two of these cave-ins moved the shovel a foot or more to one side and caused delays of 5 to 6 hours while the shovel was being dug out by hand and the jack arms made solid.

Outfit.—The outfit was a new one, the shovel, cars and other tools for the most part having been bought new. The shovel was a Bucyrus 65 ton, with a $2\frac{1}{2}$ cu. yd. dipper, with 14x14 in. crowding engines on the boom. It had a steel house on it. Such houses are of value as a protective against fire, but for all other purposes a wooden house is to be preferred. In the ordinary wear and tear of the machine, the corrugated metal becomes dented and bent and cannot be repaired, and where blasting is done around the shovel holes are made easier in the house, where it is of steel, and to repair the house new plates of metal must be put on, while with a wooden house just the area of the hole need be repaired. Then, too, the paint does not peel off of the wood as it does off the steel. The shovel used had only one piece of timber on it, a piece to protect the hoisting chain. The dipper was speeded to make 4 dips per minute, and in good material it sometimes did it, loading 12 cars, 36 dipperfuls, in 9 minutes. The dipper had a lift of 17 ft. and could dig earth 27 ft. to one side, dumping 24 ft. on the other side, thus covering a distance of 51 ft. By placing the shovel on crib work, the shovel could dig 5 ft. below the base of rail. This style of shovel, equipped with extra short arm jacks, is well adapted to grade revision work on railroads, as it is not too heavy to move over wet ground, and has such a range of work as to admit of handling heavy excavation, with a minimum of track laying and shifting. Such a shovel also saves many moves forward in heavy excavation. When the pit is dry, this shovel could be moved in from 3 to 4 minutes, although it has been moved in 2 minutes. In wet, soft pits, when cribbing is necessary to hold up the shovel and jack arm blocks, from 5 to 10 minutes are consumed in moving the shovel forward. The water tank on the shovel had a capacity of about 1,500 gallons.

Two Rogers locomotives were used. These had 16-in. cylinders and four 51-in. driving wheels. They were second hand

engines just from the shop, and each had had a new boiler put on it within 5 years. Their tanks carried about 3,000 gallons of water. Both of these engines did good service.

Each train was made up of 12 Kilbourne and Jacobs 6 yd. two way dump cars. A record of the cars loaded each day was kept, and this divided into the yardage given in the engineer's estimate showed each car carried $4\frac{1}{2}$ cu. yds. place measurement. Ordinarily 4 dippers of earth loaded a car, so each dipper load amounted to $1\frac{1}{2}$ cu. yds. place measurement.

A gasoline pump pumped water direct to the steam shovel, and also pumped water into a 10,000 gal. wooden tank for the locomotives.

A $3\frac{5}{8}$ in. Ingersoll drill was used in drilling the rock, steam being furnished from the boiler of the shovel. This drill was capable of putting down a 20 ft. hole.

The cost of the outfit was \$27,000, being divided as follows:

Shovel	\$10,000
2 locomotives.....	10,000
24 6-yd. dump cars.....	3,000
Tanks, pumps, etc., for water.....	1,000
Rock drill, etc.....	400
Blacksmith shop.....	200
Hydraulic jacks, etc.....	400
Small tools.....	1,000
Camp	1,000
Total	\$27,000

Accident.—The shovel had been set up and was ready to dig dirt by Saturday night. It had to be moved about 300 ft. to place it against the breast of the cut so it could begin digging. The intervening distance was over ground that had been excavated by teams a month previous and was well soaked by the rains that had occurred since the teams had stopped work. Realizing that the track was soft, 8x8 in timbers, 30 ft. long, had been placed under the ties beneath the rails, so as to stiffen the track. The shovel, with the boom centered and braced with timbers, started over this track under its own power. The shovel was geared to move 8 miles an hour. Great care was exercised, but when the shovel was 100 ft. from the breast and immediately over a rail joint, and it so happened over a jointing of the timbers which had not been overlapped, but simply butted end to end, the angle plate of the rail joint buckled, and before the shovel could be moved either backwards or forwards, it careened to one side and fell over, the shovel and the boom resting on the main line of the railroad. The boom was the last to hit the ground and it broke a rail on the main line where it hit the track. The shovel runner jumped out of the window of the shovel. The fall opened the throttle and all the engines on the shovel began to run at high speed and water and steam shot out of the stack and was thrown about 100 ft. The shovel runner jumped back onto the shovel and shut the throttle. The first thing to be

done was to send out flagmen to stop trains, a passenger train then being overdue.

The superintendent of the railroad was immediately notified and requested to send a wrecking train. Meantime the boom was disconnected from the shovel and the dipper and dipper arm taken off of the boom and hauled to one side. The boom with the dipper complete weighed 22 tons. The boom thus stripped, was jacked up with hydraulic jacks kept in the outfit, and a crib built under it so as to move it off the track by rollers. By the time the wrecking train arrived, the boom had been moved off the track. Several freight trains and two passenger trains had been blocked by the wreck by this time, and these were sent back to side tracks. The wrecking crane was an old 35 ton steam shovel of the crane type rebuilt into a wrecking machine and it was not powerful enough to pick up the shovel.

It was accordingly decided to place two "deadmen" or anchors in the ground on the side of the shovel away from the main line track and pull the shovel up in this manner. This was done, but owing to the soft ground the first "deadmen" pulled out. New ones were sunk much deeper and ties used to brace them. A line was hitched around the boiler of the shovel and another to the "A" frame and heavy triple blocks used between the shovel and the deadmen. Then two locomotives were hitched to each of the lines, and started off in opposite directions. The shovel was thus pulled over onto its wheels, setting in the mud.

About midnight rain began to fall and this retarded the work. By 5 o'clock in the morning the track was repaired and traffic was resumed.

On Monday began the work of repairing the shovel. The hydraulic jacks raised the car high enough to build a track under it. Several gear wheels were broken on the boom and new ones were ordered by telegraph and put in place when they arrived. The dipper arm had been bent, and it had to be straightened. All of these things were done by the contractor's own forces in a week, and the shovel was again ready to go to work. The steel house was battered up somewhat, but a handy blacksmith fixed up all but the corrugated plates, and several of these were replaced a few months afterwards.

Cost of Repairs.—The cost of the repairs was about \$1,100. Of this, \$325 was for new parts for the shovel. The railroad company's charges were \$80 and the labor charges of men working on the shovel and waiting to go to work, such as train crews, amounted to \$700. This included office men and all general expenses. This labor cost has been included in with the two months' work that is being described, as the contractor included it in with his regular pay roll and it was charged against the work done that month. The repair bill and

the railroad company's charge have not been included in with the costs to be given below. These were considered charges against the whole job. The total cost of the accident charged against the yardage moved at this point would amount to less than 1 cent per cu. yd.

Upon another occasion the shovel came near falling, owing to a block slipping from under one of the jack arms, but the shovel runner caught the shovel by thrusting his dipper down hard against the ground, holding the shovel until it could be jacked up and the block replaced.

Methods of Working.—In order to operate the contractor's trains the railroad company furnished a telegraph operator, but the contractor boarded him free of charge. The dirt train operated on "work train orders." The railroad company kept an inspector on the work, and with the company's permission the contractor paid him a salary and put him in charge of the dumps as superintendent of dumps. This was found to be a very satisfactory arrangement.

The temporary trestle was about 25 ft. high. It was built of round poles, costing 3 cts. per ft. delivered on the ground. The braces used were 3x8 in., and the stringers were 12x12, 18 ft. long, the bays of the trestle being 16 ft. long. This timber (pine) cost \$10 per M ft., B. M. The trestle was erected by a sub-contractor for \$3 per M. This gave a cost for the temporary trestle complete of 1 $\frac{3}{4}$ cts. for each cu. yd. dumped from the trestle. Only one-half the material excavated in these two months went to this trestle.

The men making up the train crews had to pass the examination given by the railroad company to men occupying similar positions, and in their work were subject to the rules and regulations of the railroad company.

The blasting of the rock had to be done with great care, so as not to interfere with the traffic on the railroad. Large boulders were loaded with the shovel by means of chains. One boulder measuring 4 cu. yds. was raised off the ground by the shovel, but as there was danger of breaking the car with it, it was not loaded. All the drilling for the blasting, both deep holes and block holes, was done by the steam drill. To protect the point of the shovel a canvas curtain was hung up, when blasting was going on, and 2 in. boards were put on top of the shovel to protect the roof. The cost of blasting is included in the cost of loading.

Cost of Work.—Below is given the total cost of the two months' work, including all cost to the contractor except the expenses incurred at his home office. With a large number of jobs going on this item of expense would be small. A ten hour day was worked. The following prices were paid for supplies:

Black powder, per keg.....\$1.25
Dynamite, per lb......11

Exploders (average).....	.06
Fuse, per 100 ft.....	.45
Caps, per 100.....	.60
Coal (run of mines), per ton.....	3.25

The total cost of the work for the two months was:

Office and superintendence:	
Engineer in charge.....	\$ 300.00
1 book keeper.....	130.00
1 clerk.....	80.00
1 telegraph operator's board.....	30.00
1 night watchman.....	70.00
1 cook and 1 flunky.....	130.00
1 superintendent.....	280.00
Oil for camp.....	14.00
	\$1,034.00

Loading:	
1 shovel runner.....	\$ 280.00
1 cranesman.....	180.00
1 fireman.....	60.00
2 pitmen.....	132.50
4 pitmen.....	212.00
Blasting:	
Steam drill and drilling.....	\$ 42.50
Powder and dynamite.....	52.00
Exploders, etc.....	16.00
73 tons coal.....	237.25
Oil, gear shield, etc.....	21.00
Repairs to shovel.....	15.00
	\$1,248.25

Hauling:	
2 locomotive enginemmen.....	\$ 360.00
2 firemen.....	160.00
2 conductors.....	300.00
4 flagmen.....	212.00
1 car oiler.....	53.00
200 tons coal.....	650.00
Engine and car repairs.....	30.00
Oil, waste, etc.....	50.00
	\$1,823.00

Dumping:	
1 inspector.....	\$ 80.00
1 fireman.....	132.50
12 men.....	636.00
1 fireman.....	159.00
20 men.....	1,060.00
Temporary trestle, 16,100 cu. yds. at 1 $\frac{3}{4}$ cts.....	281.75
	\$2,349.25

Miscellaneous:	
1 blacksmith.....	\$169.00
1 blacksmith helper.....	53.00
Extra gang:	
1 foreman, 1 month only.....	51.00
10 men, 1 month only.....	270.00
	\$546.00

Total labor and supplies.....	\$7,000.00
Interest and depreciation.....	\$1,080.00

Grand total.....\$8,080.50

Interest and depreciation does not include repairs and is charged at the rate of 2 per cent per month, worked. This is an ample allowance.

The output of the shovel per day worked

was nearly 700 cu. yds., but for the full number of working days in the two months the output per day averaged about 600 cu. yds. The average cost per cu. yd., including both earth and rock, for the details of the work, was:

Office and superintendence.....	\$0.033
Loading.....	0.040
Hauling.....	0.059
Dumping.....	0.079
Miscellaneous.....	0.018
Interest and depreciation.....	0.035
Total.....	\$0.264

Where earth and rock are moved jointly it is not possible to keep the actual cost of each class of excavation, but the total cost of the two can be kept, and a comparative cost with the contract price for the earth and rock can be calculated. This is a cost that can be relied upon, one of the editors of this journal having used such comparative costs in estimating on work, and the cost records kept have verified the estimates.

To illustrate the comparative cost an example will be given. If earth is being excavated for 35 cts. and rock for 75 cts. and 10,000 cu. yds. of earth and 5,000 cu. yds. of rock are excavated, and there is made a profit of 15 per cent on the work, then the cost of the earth excavation will be 85 per cent of 35 cts. or 29 $\frac{3}{4}$ cts., and the cost of the rock excavation will be 85 per cent of 75 cts., or 63 $\frac{3}{4}$ cts.

Such costs on this work figured out, there being a profit made of nearly 20 per cents, gives a detail unit cost per cu. yd. of earth of the following:

Office and superintendence.....	\$0.032
Loading.....	0.037
Hauling.....	0.054
Dumping.....	0.072
Miscellaneous.....	0.017
Interest and depreciation.....	0.033
Total.....	\$0.245

The cost of the rock excavation per cu. yd. was:

Office and superintendence.....	\$0.085
Loading.....	0.098
Hauling.....	0.148
Dumping.....	0.190
Miscellaneous.....	0.046
Interest and depreciation.....	0.089
Total.....	\$0.656

It will be noticed that the wages paid laborers on this job were low, but other employees were paid standard wages or higher ones.

The following table of car measurements is to be used in the Central Division of the Isthmian canal construction work as a basis for calculating yardage:

Lidgerwood flats.....	20 cu. yds.
Large Western dumps.....	17 cu. yds.
Small Western and Oliver dumps.....	10 cu. yds.
French dumps.....	5 cu. yds.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Voids, Settlement and Weight of Crushed Stone.

With the increased activity in macadam road construction and the great increase in the use of concrete, crushed stone has become an important material of construction in engineering work. Very little has been printed regarding the properties of crushed stone, and few, if any, attempts on an adequate scale have been made heretofore to determine its weights, voids and settlement and the variations of these. During the past year the engineering experiment station of the University of Illinois has been gathering data and conducting tests on these subjects. The results of these tests and observation have been published in a bulletin prepared by Prof. Ira O. Baker, and the matter in this article has been taken from the above-mentioned bulletin.

The tests were made on limestones quarried at Chester, Joliet and Kankakee, Ill. The Chester stone is a rather coarsely granulated, gray limestone of the lower carboniferous group, and is quarried in the grounds of the State Penitentiary, about half way between St. Louis and Cairo. The Joliet stone is a compact, fine-grained magnesian limestone of the Niagara series, and is quarried in the grounds of the State Penitentiary at Joliet, about 40 miles southwest of Chicago. The output of the crusher consists of 28 per cent 3-in. stone, 52 per cent 2-in and 17 per cent 1½-in. The Kankakee stone is a coarse-grained argillaceous limestone of the Niagara group, and is quarried at Kankakee, on the Kankakee river, about 55 miles south of Chicago.

Tests were made on the crushed stone to determine the specific gravity, the absorptive power, the percentage of voids, the settlement in transit, and the weight per cubic yard.

Specific Gravity.—The specific gravity was determined by the use of the formula:

$$\text{Specific gravity} = \frac{W_a}{W_a - W_w}$$

in which W_a is the weight of the fragment weighed in air and W_w the weight of the same fragment suspended in water. Samples of the stone were collected from various parts of the quarries and the values of their specific gravity determined. As the results of the tests, the means specific gravity for the Joliet limestone was found to be 2.71, for the Chester limestone it was 2.57, and for the Kankakee limestone 2.61.

Absorptive Power.—The absorptive power of the limestone was determined by thor-

oughly drying a specimen, weighing it, immersing it in water for 96 hours, drying with blotting paper and weighing. The average of the results obtained were as follows:

	Weight in lbs. per cu. ft.	Absorption lbs. per cu. ft.	per cent by wt.
Joliet stone.....	169.18	1.09	0.64
Kankakee stone....	163.04	3.04	1.84
Chester stone.....	161.2	1.67	1.01

Percentage of Voids.—This was determined in two ways: (1) By finding the weight of water a given vessel will contain and then filling the vessel with broken stone and determining the weight of water that can be poured into the interstices of the broken stone; the ratio of the first amount of water to the second is the proportion of voids. (2) By computation from the specific gravity and the weight of a volume of broken stone. By this method the weight of a known volume of broken stone was determined, and the weight of an equal volume of the solid stone computed by multiplying the known volume by the weight of an equal volume of water and the specific gravity of the stone. The difference between the weight of the volume of solid stone and that of the broken stone is the weight of stone equal to the volume of the voids. The ratio of this weight to the weight of the given volume of broken stone is the proportion of voids. This method is more exact than (1).

In making the tests precautions were taken to eliminate absorption by the walls of the vessels used. In each case also the results were corrected for the absorption of stone. The distance of drop employed in filling the vessels corresponded to that employed at the time in loading cars of broken stone. In the tests on the Chester limestone a vessel containing 27 cu. ft. was used in the first series of tests, the drop in filling being 15 ft. A vessel

The Kankakee stone was measured in vessels containing 2.11 cu. ft., 1.15 cu. ft., and .691 cu. ft., an 8-ft. drop being used in filling. From the tests it was found that for any size vessel used the average percentages were fairly uniform, the greatest variation being in the case of 3-in. to 2-in. stone. It was also found that in tests where the 15-ft. and 20 ft. drops were used that the stone falling 20 ft. invariably had a smaller percentage of voids than that falling only 15 ft. In other words, the density increased with the fall. A summary of the results obtained are shown in the following table, which gives the percentage of voids for the different sizes of stone:

Location of quarry.	Size of stone.	Per cent of voids, By pouring in water.	From specific gravity.
Chester...¾ in. Ser.		40.9	46.8
Chester...¾ in. Ser.		13.0	45.6
Chester...2 in. to ¾ in.		46.6	46.6
Chester...3 in. to 2 in.		46.1	45.1
Joliet...½ in. Ser.		42.2	47.1
Joliet...2 in. to ½ in.		47.9	46.2
Joliet...3 in. to 2 in.		47.5	46.1
Kankakee...¾ in. Ser.		39.6	46.1
Kankakee...1½ in. to ¾ in.		45.7	44.7
Kankakee...2½ in. to ¾ in.		44.3	42.9
Kankakee...2½ in. to 1½ in.		46.2	43.4

Settlement in Transit.—Experiments were made to determine the settlement of crushed stone during transit in wagons and also in railway cars. In the tests to determine the settlement in wagons, observations were first made to determine the relation between the settlement in wagons and the distance hauled. An attempt was made to determine the amount of settlement for regular increments in the distance hauled. This was done by stopping the team and taking a measurement each successive 100 ft. until the settlement for that distance was too small to measure. The measurements in all cases were taken by using two straight edges, one placed across the top of the box and the other resting on top of the stone. Then as both straight edges were of the same width, each measurement was taken from the top of the upper one to the top of the lower one. Measurements were taken near each side and on the center line, near the front, middle and back of the load, making a total of nine measurements for each load. The data for Chester limestone are given in Table 1. The haul was over about equal distance on macadam, cinders and earth, and the results were obtained within a day or two

TABLE NO. 1.—EFFECT OF DISTANCE HAULED UPON SETTLEMENT IN WAGON.

Size of stone.	Method of loading.	Per cent of settlement for hauls of feet.									
		100	200	300	400	500	600	700	2640	5280	
¾ in. Ser.†.....	15 ft. drop	7.3	8.3	8.9	92.2	9.5	10.1	10.1	11.2	11.2	
¾ in. Ser.†.....	15 ft. drop	5.0	9.7	10.2	10.2	10.4	10.4	10.7	12.4		
2 in.-¾ in. Ser.†.....	15 ft. drop	2.6	3.7	4.9	5.3	5.3	5.3	5.4	5.4	5.4	
2 in.-¾ in. Ser.†.....	15 ft. drop	5.3	6.2	7.1	7.7	7.9	8.0	8.3	9.2		
2 in.-¾ in. Ser.†.....	Shoveled	3.5	4.1	4.8	5.3	5.3	5.7	6.5	7.3		
3 in.-2 in. Ser.†.....	15 ft. drop	0.57	2.6	2.8	4.1	4.25	4.25	4.25	4.9	4.9	
3 in.-2 in. Ser.†.....	15 ft. drop	3.5	4.2	4.5	4.8	5.0	5.0	5.1	6.0	6.0	
3 in.-2 in. Ser.†.....	Shoveled	5.0	5.7	6.53	6.53	6.7	6.7	6.7	7.1	7.1	

containing 2.6 cu. ft. was used in the second series, the method of filling being by shoveling and by 20 ft. drop. In the tests of the Joliet limestone a vessel containing 2.34 cu. ft. was used for the greater part of the test, the method of filling being by an 8-ft. drop and a 4-ft. drop.

of each other. The results varied surprisingly, and about the only safe conclusions that could be drawn from these data were: (1) About half of the settlement occurs in the first 100 ft. and (2) the settlement at half a mile is practically the same as that at a mile. In the experiments on transit

of crushed stone in railway cars, the settlement was measured by the same method as for wagons. It was found that the settlement varied greatly for stone of the same size, loaded the same day, and shipped to the same destination on the same train. A summary of the data on settlement obtained from the tests is as follows:

Location of quarry	Size of stone.	Settlement after a haul of	
		1/2 mile or more in wagons.	1/2 mile or more in cars.
Chester..... $\frac{3}{4}$ in. Ser.		12.7	10.6
Chester..... $\frac{3}{4}$ in. Ser.		11.8	10.6
Chester..... $\frac{3}{4}$ in. Ser.		9.2	7.0
Chester..... $\frac{3}{4}$ in. Ser.		8.2	7.0
Joliet..... $\frac{3}{4}$ in. Ser.		9.1	8.4
Joliet..... $\frac{3}{4}$ in. Ser.		9.7	9.7
Joliet..... $\frac{3}{4}$ in. Ser.		6.6	7.4
Joliet..... $\frac{3}{4}$ in. Ser.		9.4	7.8
Joliet..... $\frac{3}{4}$ in. Ser.		10.0	7.8
Kankakee..... $\frac{3}{4}$ in. Ser.		10.0	7.8
Kankakee..... $\frac{3}{4}$ in. Ser.		10.0	7.8
Kankakee..... $\frac{3}{4}$ in. Ser.		5.4	5.4

Weight Per Cubic Yard.—Tests to determine the weight of a unit of volume of crushed limestone were made both in wagons and in cars, at the same time the record was taken of the settlement. Before beginning to load a car, measurements were taken from a straight edge laid on top of the car body to the floor of the car. These measurements were taken on each side of the car and at the center transversely, and at each end and the middle longitudinally. The stone was loaded into the cars by means of a chute in the bottom of the bin. After the car was loaded the upper surface was leveled off, and the depth of stone below the top of the car body was determined by measuring down from a straight edge across the top of the car to a similar straight edge lying on the crushed stone. From the above measurement the volume of the stone was computed. The cars were then switched to the scale track, where they were weighed. From these data the weight per cubic yard of the loose stone was computed. Measurements similar to those made at the crusher were taken when the car reached its destination, and the weights per unit of volume of the stone when compacted were computed as before.

The average of the tests are shown in the accompanying table, which gives the results in pounds per cubic yard:

the means being given in such a manner as to show the average result for each size.

It will be noticed that the coefficient is largest for the finest stone and smallest for the intermediate size. The same holds

TABLE II.—COEFFICIENTS BY WHICH TO DETERMINE THE WEIGHTS IN POUNDS PER CUBIC YARD OF CRUSHED LIMESTONE.

Kind of stone.	Size of stone.	Wt. of solid stone, lb. per cu. ft.	Having the weight of a cu. ft. of solid stone.		Having the weight of a cu. yd. of solid stone.		Having the specific gravity of stone.		Wagon.
			Car.	Wagon.	Car.	Wagon.	Car.	Wagon.	
Chester..... $\frac{3}{4}$ in. Ser.		160.4	15.9	15.3	4331	0.588	0.566	2.57	954.5
Joliet..... $\frac{3}{4}$ in. Ser.		169.1	15.7	13.6	4566	0.582	0.504	2.71	849.3
Joliet..... $\frac{3}{4}$ in. Ser.		169.1	15.4		4566	0.572		2.71	963.8
Kankakee..... $\frac{3}{4}$ in. Ser.		162.8		14.9	4397		0.553	2.61	931.0
Mean..... $\frac{3}{4}$ in. Ser.		165.4	15.7	14.6	4465	0.581	0.541	2.65	911.8
Kankakee..... $\frac{1}{4}$ in. Ser.		162.8		14.3	4397		0.529	2.61	890.8
Chester..... $\frac{1}{2}$ in. Ser.		160.4		14.6	4331		0.541	2.57	912.1
Joliet..... $\frac{1}{2}$ in. Ser.		169.1	14.1	13.7	4566	0.523	0.507	2.71	880.4
Joliet..... $\frac{1}{2}$ in. Ser.		169.1	13.6		4566	0.503		2.71	847.2
Kankakee..... $\frac{1}{2}$ in. Ser.		162.8	13.9		4397	0.514		2.61	865.9
Mean..... $\frac{1}{2}$ in. Ser.		165.4	13.9	14.2	4465	0.513	0.524	2.65	864.5
Chester..... $\frac{1}{2}$ in. Ser.		160.4	14.9	14.8	4331	0.554	0.546	2.57	933.1
Joliet..... $\frac{1}{2}$ in. Ser.		169.1	14.0		4566	0.517		2.71	871.2
Mean..... $\frac{1}{2}$ in. Ser.		164.8	14.4	11.8	4448	0.536	0.546	2.64	902.2
Chester..... $\frac{3}{8}$ in. Ser.		160.4	17.8	17.6	4331	0.658	0.651	2.57	1108.9
Joliet..... $\frac{3}{8}$ in. Ser.		169.1	17.2	15.0	4566	0.636	0.555	2.71	1072.0
Joliet..... $\frac{3}{8}$ in. Ser.		169.1	16.9		4566	0.625		2.71	1053.5
Kankakee..... $\frac{3}{8}$ in. Ser.		162.8		16.6	4397		0.613	2.61	1033.3
Mean..... $\frac{3}{8}$ in. Ser.		165.4	17.3	16.6	4465	0.640	0.606	2.65	1078.1
Kankakee..... $\frac{1}{4}$ in. Ser.		162.8		15.6	4397		0.579	2.61	975.5
Chester..... $\frac{1}{4}$ in. Ser.		160.4		16.1	4331		0.596	2.57	1004.7
Joliet..... $\frac{1}{4}$ in. Ser.		169.1	15.3	14.7	4566	0.568	0.543	2.71	956.5
Joliet..... $\frac{1}{4}$ in. Ser.		169.1	14.9		4566	0.551		2.71	928.4
Kankakee..... $\frac{1}{4}$ in. Ser.		162.8	14.7		4397	0.544		2.61	915.7
Mean..... $\frac{1}{4}$ in. Ser.		165.4	15.0	15.4	4465	0.554	0.570	2.65	933.5
Chester..... $\frac{1}{4}$ in. Ser.		160.4	15.9	16.0	4331	0.588	0.593	2.57	990.2
Joliet..... $\frac{1}{4}$ in. Ser.		169.1	15.1		4566	0.559		2.71	942.0
Mean..... $\frac{1}{4}$ in. Ser.		164.8	15.5	16.0	4448	0.574	0.593	2.64	966.1

TABLE III.—COEFFICIENTS BY WHICH TO DETERMINE THE WEIGHT IN POUNDS PER CUBIC YARD OF CRUSHED TRAP.

Size of stone.	Having the weight of a cubic foot of solid stone.		Having the weight of a cubic yard of solid stone.		Having the specific gravity of stone.	
	Wt. of sol. stone lb. per cu. yd.	Coefficient.	Wt. of sol. stone lb. per cu. yd.	Coefficient.	Specific gravity.	Coefficient.
$\frac{1}{2}$ in. screenings	180.7	14.6	4879	0.541	2.90	914.4
$\frac{1}{2}$ in. to $\frac{1}{4}$ in.	180.7	13.5	4879	0.500	2.90	839.7
$\frac{3}{8}$ in. to $\frac{1}{2}$ in.	180.7	13.9	4879	0.515	2.90	872.2
Mean		13.7		0.519		875.4

The following summary of Table II shows the mean coefficient by which to multiply the weight of a cubic foot of solid limestone to obtain the weight of a cubic yard of crushed stone:

Wagon loads.		Car loads.	
Wt. at crusher.	After a haul of 1/2 mile or more.	Wt. at crusher.	After a haul of 1/2 mile or more.
2203	2533	2659	2905
		2652	2882
2315	2480	2386	2592
		2296	2516
		2361	2553
2442	2797	2546	2850
2344	2582		
2367	2569		
2430	2697	2348	2545
2325	2546		
		2260	2390

Coefficients for Determining Weights of Crushed Stone.—As the result of these tests coefficients were determined by which can be deduced the weight per unit of volume of crushed stone when the weight of a unit of solid stone or the specific gravity is known. Table II shows these coefficients.

Size of stone.	Mean coefficient.
$\frac{1}{2}$ -in. screenings	15.5
$\frac{1}{2}$ -in. to $\frac{1}{4}$ -in.	14.6
$\frac{3}{8}$ -in. to $\frac{1}{2}$ -in.	15.2
Average	15.1

true for trap rock, as will be shown later, even though the sizes slightly differ. This seems to prove that the weight of screenings is greater than that of coarser stone, while the weight of the intermediate size is less than that of either size.

Weight and Voids of Crushed Trap.—These tests were made by Mr. W. E. McClintock, at present chairman of Massachusetts Highway Commission, and were described by him in the Journal of the Association of Engineering Societies, Vol. 11 (1892). In the first experiment Mr. McClintock weighed the contents of a bin holding 29½ cu. yds., the average drop of the stone into the bins being about 9 ft., and found the weight of stone that had passed a ½-in. screen to be 2,605 lbs. per cubic yard, and in another test under the same conditions, to be 2,690 lbs.; and when the broken stone was wet the weight was 2,480 lbs. per cubic yard. In another experiment he weighed the stone in a bin holding 89.8 cu. yds., and found the weight

of stone that had passed a 1½-in. screen and had been caught on a ½-in. screen to be 2,423 lbs. per cubic yard. In a third experiment he weighed the stone in a bin containing 89.7 cu. yds. and found the weight of the stone that had passed a 3-in. screen and had been caught on a 1½-in. screen to be 2,522 lbs. per cubic yard. He also measured six cars and weighed the contents, and found the weight of the last mentioned size to be 2,531 lbs. per cubic yard. The following statement shows the relative proportions of the several sizes of crushed trap:

Size of stone.	Per cent.
½-in. screenings.....	13.24
1½-in. to ½-in.....	23.89
3-in. to 1½-in.....	62.87

Total output of crusher.....100.00

From the weight per cubic foot of solid stone given by Mr. McClintock and the above weights of the broken stone, the per cent of voids was computed. A summary of Mr. McClintock's experiments, showing the weight and voids of crushed trap, are as follows:

Size of stone.	Weight in lb. per cu. yd.	Per cent of voids, computed.
½ in. screenings, in bin, dry.....	2635	
½ in. screenings, in bin, dry.....	2690	
Mean	2648	46.5
½ in. screenings, in bin, wet.....	2480	
1½ in. to ½ in. in bin.....	2432	50.2
3 in. to 1½ in. in bin.....	2522	
3 in. to 1½ in. in cars.....	2531	
Mean	2526	48.1

Table III shows the coefficients for the trap rock.

Cost of Road Construction in New Jersey in 1907, and Per Cent of Engineering Cost of the Work.

The accompanying table, compiled from the annual report of the Commissioner of Public Roads of New Jersey for 1907,

shows the cost per mile of a number of roads constructed in that state in 1907. The roads were constructed by contract and the cost as given in the table is the total cost and includes supervisor's salary, engineering expenses and extras. The average cost per mile of constructing an 8-in. 14-ft. wide macadam road was about \$10,885, while the average cost per mile for a 6-in. 14-ft. road was about \$8,335. The per cent of engineering expenses to the total cost varied from 4.6 to 2.1, the average being 3.2 per cent. Included in the table are the contract prices on the principal items for each road.

Abrasion and Toughness Tests for Road Building Rock.

At the 11th annual meeting of the American Society for Testing Materials at Atlantic City the Committee on Standard Tests for Road Materials recommended that the specifications for the abrasion test, reported by that committee in 1904, and the specifications for the toughness test, reported in 1905, be adopted by the Society. This recommendation was adopted and the specifications sent out to letter ballot for adoption. The specifications are as follows:

"Abrasion Test.—The machine shall consist of one or more hollow iron cylinders closed at one end and furnished with a tightly-fitting iron cover for the other, the cylinders to be 20 cm. in diameter and 34 cm. in depth inside. These cylinders are to be mounted on a shaft at an angle of 30 deg. with the axis of rotation of the shaft.

"At least 30 lbs. of coarsely broken stone should be available for a test. The rock to be tested should be broken in pieces as nearly uniform in size as possible, and as near 50 pieces as possible should constitute a test sample. The total weight of rock

in a test should be within 10 gm. of 5 kg. All test pieces should be washed and thoroughly dried before weighing. Ten thousand revolutions, at the rate of between 30 and 33 to the minute, must constitute a test. Only the percentage of material worn off which will pass through a 0.16 cm. (1/16-in.) mesh sieve should be considered in determining the amount of wear. This may be expressed either in the per cent of the 5 kg. used in the test, or the French coefficient, which is in more general use, may be given; that is, coefficient of wear = $20 \times 20 \div W = 400 \div W$. W being the weight in grams of the detritus under 0.16 cm. (1/16 in.) in size per kilogram of rock used.

"Toughness Test.—Test pieces may be either cylinders or cubes, 25 mm. in diameter and 25 mm. in height, cut perpendicular to the cleavage of the rock. Cylinders are recommended, as they are cheaper and more easily made.

"The testing machine shall consist of an anvil of 50 kg. weight, placed on a concrete foundation. The hammer shall be 2 kg. weight and dropped upon an intervening plunger of 1 kg. weight, which rests on the test piece. The lower or bearing surface of this plunger shall be of spherical shape, having a radius of 1 cm. This plunger should be made of hardened steel and pressed firmly upon the test piece by suitable springs. The test piece should be adjusted so that the center of its upper surface is tangent to the spherical end of the plunger.

"The test should consist of 1 cm. fall of the hammer for the first blow and an increased fall of 1 cm. for each succeeding blow until failure of the test piece occurs. The number of blows necessary to destroy the test piece is used to represent the toughness or the centimetergrams of energy applied may be used."

COST PER MILE AND PER CENT OF ENGINEERING COST FOR STATE ROAD WORK IN NEW JERSEY IN 1907.

				—Contract Prices.—									
				Cost	Per	Earth		Gravel.		Macadam.		Telford	
Place.	Kind.	Dpth. Ins.	Wdth. Ft.	Per Mile.	Cent Eng.	Excavation.	Bid.	Cu. yds.	Bid.	Sq. yds.	Bid.	Sq. yds.	Bid.
Hammononton	Gravel	8 ¹	16	6.41	\$5,680	4.3	22,426	\$0.23	12,774	\$1.95	.....	.....	.....
Etna	Macadam	8	14	1.14	7,268	3.6	3,781	.....	.....	9,526	.....	.....	.....
Haddon	Macadam	8	14	3.15	11,635	2.8	15,807	.30	.....	26,978	\$0.91	.....	.....
Waterford	Gravel	6	14	4.05	2,718	.....	16,836	.33	5,533	.85 ¹	.....	.....	.....
Pensauken	Macadam	6	14	1.78	8,500	2.9	6,677	.30	.....	14,580	.....	.....	.....
Centre	Macadam	8	14	2.53	11,890	2.8	15,339	.20	.....	20,676	1.12	.....	.....
Centre	Macadam	8	14	1.55	11,220	2.8	10,182	.20	.....	12,713	1.04	.....	.....
Clementon	Macadam	6	14	.98	8,246	2.8	2,568	.....	.....	7,989	.....	.....	.....
Middle	Gravel	12 ²	14	4.00	5,444	3.3	14,100 ³	.28	4,991 ⁴	1.55	.....	.....	.....
Caldwell	Telford	8	16	2.50	9,950	.....	12,679	.45	.....	.....	.....	23,505	\$0.80
Verona	Telford	8	16	1.46	54,800	.....	79,129 ⁵	.89	.....	.....	.....	13,929	.55
West Orange	Telford	8	16	1.07	31,163	.....	34,727	.72	.....	.....	.....	10,053	.57
East Amwell	Macadam	6	14	5.37	8,490	.....	18,419 ⁶	.50	.....	42,692	.60	1,244	1.88
Ewing	Macadam	6	14	.79	7,592	.....	3,100	.40	.....	6,517	.64	.....	.....
Hamilton	Macadam	10	33.6	.49	15,898	.....	2,400	.30	.....	6,977	.96	.....	.....
Hamilton	Macadam	6	18	1.50	8,846	.....	4,880	.32	.....	13,325	.72	.....	.....
Ewing	Macadam	8	16	.75	9,189	.....	2,645	.30	.....	7,126	.74	.....	.....
Hamilton	Macadam	6	14	1.39	8,085	.....	2,525	.30	.....	12,028	.65	.....	.....
Hamilton	Macadam	6	16	.93	7,040	.....	3,020	.15	.....	8,626	.90	.....	.....
Cranbury	Macadam	8	14	2.27	10,447	.....	20,549	.28	.....	7,855	.87	.....	.....
Piscataway	Macadam	8	14	.96	10,559	.....	4,270	.25	.....	17,905	1.00	.....	.....
Atlantic	Macadam	8	14	2.18	11,300	2.4	20,466	.24	.....	5,639 ⁷	.55	.....	.....
Roxbury	Macadam	8	14	.69	13,304	2.6	13,530	.33	.....	.....	.....	.....	.....
Berkeley	Gravel	9	24	6.91	4,200	4.6	11,839	.28 ^{1/2}	17,569	.80	.....	.....	.....
West Milford	Macadam	4	14	.86	24,090	.....	21,352 ⁸	.30	.....	7,509	.18	.....	.....
Paterson	Macadam	5	28	.26	9,600	.....	720	.30	.....	4,344	.50	.....	.....
Pompton	Macadam	4	16	3.01	8,690	.....	9,954 ⁹	.38	.....	27,017	.42	.....	.....
Branchburgh	Macadam	8	14	3.13	9,526	3.2	15,593	.40	.....	25,517	.75	.....	.....
Bernards	Macadam	6	14	1.03	9,100	.....	7,480	.40	.....	8,336	.62	.....	.....
Bridgewater	Macadam	8	14	3.12	10,328	3.5	24,774	.40	.....	25,237	.75	.....	.....
Rahway	Macadam	12	16	1.95	7,756	3.3	1,855	.38	.....	7,378 ¹⁰	.90	1,432	1.20
Westfield	Macadam	6	16	.38	7,285	.....	555	.50	.....	3,837	.60	.....	.....

¹ 3,000 ft. 4 in. and 30,835 ft. 8 in. ² 12 in. at center and 8 in. at shoulder line. ³ and embankment. ⁴ Class A, also 4,942 cu. yds. Class B at 92 cts. ⁵ Graded width of roadway 45 ft., materials varied from loam through gravel and brown sandstone to traprock. ⁶ There also was 6,662 cu. yds. borrowed excavation at 40 cts. ⁷ Telford-macadam. ⁸ Also 7,640 cu. yds. rock excavation at \$1.25. ⁹ Also 6,370 cu. yds. rock excavation at \$1.60. ¹⁰ Also 441 sq. yds. 6-in. macadam at 70 cts., and 9,060 sq. yds. 2-in. macadam at 22½ cts.

Water-works and Sewer Section

Note: This section is devoted to methods and costs of constructing sewers and water-works. It will cover the construction work for all details of water supply and sewerage, including sewage purification and water filtration.

Method of Excavating a Sewer Trench in Water Soaked Sand, Using the Bleeding Method of Unwatering the Soil, with Some Estimates of Costs.

In trenching for a 7-ft. sewer through water soaked sand at Gary, Ind., the sand is being unwatered by driving well points and pumping. The method has enabled what promised to be a difficult task to be accomplished with comparative ease. Only a moderate amount of sheeting has been necessary and practically no caving has resulted. These results are particularly interesting in connection with the suggestions made by one of the editors of this journal in describing and giving the cost of a similar method of unwatering the site for a filter reservoir in our issue of Aug. 15, 1906.

The sand through which the work passes is very fine, such a sand as forms the dunes of Michigan and other states bordering Lake Michigan. When water soaked it takes a slope of about 1 on 15. At Gary this fine sand is water soaked to within a few feet of the surface; in places water covers the surface. So far as excavation work goes the material is to all intents and purposes a quicksand.

General Method of Excavation.—In brief, the method of work adopted is as follows: A wide shallow trench is excavated by a drag scraper bucket excavator of the Page & Shnoble type to about water level, say to a depth of 6 to 8 ft. Bleeding is then begun. A 4-in. pipe 132 ft. long in six 22-ft. sections is stretched along the center line of the sewer. On each side of this pipe about 3 ft. away is sunk a row of well points 2 ft. apart. These well points are 3 ft. long and are attached to 13-ft. pipes. The tops of the driven pipes are connected by hose to the 4-in. pipe line which has cross-valves for the purpose. A pump connects with the 4-in. pipe line and also with a 1-in. well point sunk vertically underneath. An extension of the 4-in. pipe line with strainer end also takes the surface water from a sump.

This battery of well points lowers the water so that a further excavation of 6 to 8 ft. can be made between sheet piling. A second battery of well points is then sunk at this new level. In this battery, however, the points are sunk close to the sheeting and each row feeds into a separate 2-in. pipe along the trench. This battery lowers the water level enough to permit excavation to sub-grade, which is some 6 ft. below

the bottom of the sheeting. The brick sewer is then built in the usual manner and the back-filling done by means of a derrick and Hayward clam shell bucket.

The diagram Fig. 1 shows the general

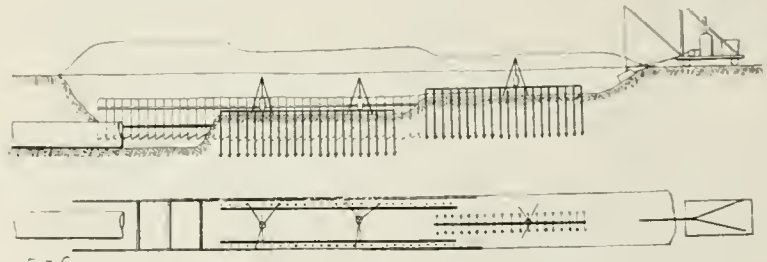


Fig. 1—Sketch Showing Arrangement of Well Points and Pumps.

plan of procedure described. In this description details have been neglected to prevent confusion; some of these details, however, require description.

Scraper Bucket Excavator Work.—The trench taken out by the scraper bucket ex-

running foot of trench, and the machine makes 60 ft. per day. This 60 ft. is not its capacity, but is the distance made daily by all the work and the excavator is worked just enough to keep pace. The depth being excavated is also limited by the water level.

The machine is mounted on rollers traveling on a track of timbers. One merit of the machine is that some of the excavated material can be dumped straight ahead in the path of the work so that it builds its own roadbed over the swamps in front. The machine is pulled ahead by simply low-

ering the bucket and letting it get a good bite in the ground ahead, then pulling on the digging cable.

The excavator is taking out about 400 cu. yds. per 9-hour day, with a gang of 1 engineer, 1 fireman and 3 laborers. The



Fig. 2—View Showing First Battery of Well Points.

cavator is shown by Fig. 2, which also shows the general construction of the machine itself. The bucket is of 2 cu. yds. capacity and is operated on a 58 ft. boom with the usual cable and chain attachments. The sand being excavated is wet; that is, the voids are filled with water. The amount of excavation is 10 cu. yds. per

cost of excavation thus figures about as follows:

1 engineer at \$5.....	\$ 5.00
1 fireman at \$3.....	3.00
1 laborers at \$2.....	8.00
Coal at \$3.60 per ton.....	6.25

Total for 100 cu. yds\$22.25

This gives a cost of about 5.5 cts. per cu. yd., exclusive of depreciation and superintendence.

First Battery of Well Points.—Referring to Figs. 1 and 2 it will be seen that the first battery of well points occupies a narrow space along the center of the trench; this permits the sheeting to be driven outside of the well points. The well points are 2 ins. x 3 ft., and they are attached to 2-in. x 13-ft. pipes with ells at their tops. A 4-ft. length of wire lined hose is attached to each ell. These points are sunk vertically by jetting. Two men were timed in jetting. They used 1-in. jetting pipes with about 100 lbs. water pressure and sunk four points in one minute. This time did not include making connections. In addition

tile drain alongside the trench; this drain leads back to the completed sewer discharging behind a temporary dam of bags of sand inside the sewer. Summarized, the first battery of well points is composed as follows.

- 1 No. 3 Emerson pump.
- 1 4-in. well point sunk below pump.
- 132 2-in. well points sunk in two rows.
- 1 4-in. suction pipe with extension to surface water sump.

Sheeting Trench.—The trench is sheeted 10 ft. wide, the sheeting being carried along so as to embrace about one section (the rearmost) of the first battery of well points. The sheeting is 2 x 8-in x 12-ft. planks and is driven by mauls. Waling pieces and trench braces are placed as the

of well points; they are of the same size and make as that for the first battery and are suspended similarly. Figure 3 shows the second battery of well points and pumps, the sheeting, waling, bracing, etc. Each pump draws water from both rows of well points and also from a 4-in. well point sunk directly under the pump. This is accomplished by means of a four-way connection in the suction of each pump, about 1 ft. below the pump. From this connection 2-in. pipes branch right and left to connections with the 2-in. suction pipes and a third connection is made with the 4-in. well point. Operating in parallel as they do the two pumps can, by means of the gate valves, concentrate their work on those portions of the battery of well points where especially large quantities of water are encountered or can pump from the whole system, also either one of the pumps can be cut out. These pumps discharge into the same tile drain as the first pump.

The methods of advancing the second battery of well points is substantially the same as for the first; that is, the rear sections of suction pipe and well points are detached and placed in front. Generally the forward end of the second battery is kept far enough ahead to overlap the rear section of the first battery as shown by Fig. 3.

Excavation and Sewer Construction.—The deepening of the trench at the rear end of the second battery of well points is done by hand. So perfect is the drainage that it is found possible to excavate some 6 ft. deeper than the bottom of the sheeting, and to construct the brick sewer in the trench bottom with no more seepage than can be handled by a fourth Emerson pump, which takes water from a sump and discharges behind the temporary sand bag dam mentioned previously.

Backfilling.—The backfilling is done from the spoil bank. As fast as the sewer is completed, shovelers cover it with a layer of sand. The remainder of the backfilling is done by an 8¼ x 10-in. Lidgerwood engine and derrick operating a 1 cu. yd. Hayward clam shell. This machine puts in about 500 cu. yds. of backfill in 9 hours at a probable cost of about 4 cts. per cu. yd. figured as follows:

1 engineman at \$5.....	\$ 5.00
1 fireman at \$3.....	3.00
3 laborers at \$2.....	6.00
Fuel at \$3.60 per ton.....	6.25

Total 500 cu. yds. at 4 cts. \$20.25

Progress and Cost.—The progress of the work is 60 ft. of completed sewer per 9-hour day. Costs of the work are not available in detail but from the pay roll and quantities available the following approximations are possible in addition to those already given for scraper bucket excavation and backfilling.

Sheeting and Bracing.—Two rows of 2 x 8-in x 12-ft. sheeting 60 ft. long are driven,



Fig. 3—View Showing Sheeting and Second Battery of Well Points.

to the two rows of 2-in. points, a 4-in. point is sunk directly under the pump.

The well points are connected by the short hose lengths mentioned to a 4-in. horizontal suction pipe. Six 22-ft. sections of suction pipe are used with flanged joints. Each section has 11 cross-valves with double bushings for the hose connections. A gate valve near the end of each section permits the rear-sections to be removed and placed ahead as fast as the work progresses. An extension of the 4-in. suction pipe forward to a sump in the excavation being made by the scraper bucket handles the surface water.

The water is drawn from the suction pipe by an Emerson No. 3 pump with 5-in. suction and 4-in. discharge. The pump is hung to a chain fall from an A-frame mounted on rollers. It discharges into a

excavation proceeds. This excavation is carried about 6 ft. by shovelers and at this level the second battery of well points is placed. The sheeting is pulled as the back filling proceeds.

Second Battery of Well Points.—The second battery of well points consists of two rows like the first, but the rows are placed wide apart (close inside the sheeting on both sides) and each has a separate suction pipe. The suction pipes are 2 ins. in diameter and the well points are 1¼ ins. in diameter; the well points and pipes are 16 ft. long and when sunk they penetrate a couple feet or so below sub-grade and 6 ft. below the bottom of the sheeting. The suction points are made in sections with hose connections every two feet and gate valves at the ends.

Two pumps operate the second battery

braced and pulled per 9-hour day with the following gang:

4 men setting braces at \$2.25.....	\$ 9.00
3 men driving sheeting at \$2.50.....	7.50
4 men pulling sheeting at \$2.50.....	10.00
1 carpenter at \$3.....	3.00

Total\$29.50

This gives a cost of 24½ cts. per lineal foot of 12-ft. sheeting driven, braced and pulled, not including materials and superintendence, etc.

Pumping and Changing Piping.—The pumping is continuous day and night, but the jetting of well points and changing of piping is confined to the regular shift of 9 hours. The gang worked is as follows:

11 pipe line men at \$2.25.....	\$31.50
10 firemen (two shifts) at \$3.....	30.00
2 foremen at \$3.....	6.00
6 laborers at \$2.....	12.00
Coal for 24 hours (estimated).....	15.00

Total\$94.50

This gives a cost of \$1.575 per lin. ft. of trench, not including superintendence, interest, depreciation, etc.

Trench Excavation.—The trench excavation, excluding scraper bucket work, runs about 300 cu. yds. per day, assuming 60 ft. of 10.5 x 13 ft. trench per 9 hours. This work is done by 85 shovelers at \$2 per day, and costs $\$170 \div 300 \text{ cu. yds.} = 56.6 \text{ cts. per cu. yd.}$

Miscellaneous.—The cost of clearing the right of way amounts to \$4 per day, 2 men at \$2 being employed. There are 3 waterboys at \$1, or a charge of \$3 per day for waterboys.

Summarizing we have the following costs for trench work complete and ready for sewer construction:

	Per Day.	Per Lin. Ft.
Scraper excavator work (400 cu. yds.).....	\$ 22.25	\$0.370
Shovel excavation (300 cu. yds.).....	170.00	2.833
Sheeting and bracing (300 cu. yds.).....	20.50	0.491
Pumping and pipe system (300 cu. yds.).....	94.50	1.575
Backfilling (500 cu. yds.).....	20.25	0.337
Miscellaneous (300 cu. yds.).....	7.00	0.116

Total\$313.50 \$5.722

Figured on a cubic yard basis these costs may be arranged as follows:

Scraper work, including clearing (400 cu. yds.).....	\$0.055
Trenching, pumping and sheeting (300 cu. yds.).....	\$0.980
Backfilling (500 cu. yds.).....	\$0.040

Sewer Construction.—About 60 ft. of sewer are completed per 9-hour day. The labor and materials cost of this work runs about as follows:

	Per Day.
30,000 brick at \$6.50.....	\$195.00
30 bbls. Portland cement at \$1.75....	52.50
30 bbls. Utica natural cement at \$1....	30.00
Total materials.....	\$277.50

Labor:

5 men mixing mortar....	\$ 2.50	\$ 12.50
5 men carrying cement mortar	2.50	12.50
3 men lowering cement mortar	2.25	6.75
6 brick masons (5,000 brick each daily).....	10.00	60.00
4 brick tenders.....	3.75	11.25
15 brick handlers (av.)....	2.50	37.50
26 men on industrial railway	2.00	52.00
3 teamsters	2.50	7.50
3 teams	9.00	27.00
3 form setters	3.25	9.75
3 water boys.....	1.00	3.00

Total labor and materials.....\$517.35

Assuming 500 brick per cubic yard of masonry, these figures give a cost of:

	Per Cu. Yd.
Materials ..	$\$277.50 \div 60 \text{ cu. yds.} = \$4.62$
Labor ..	$\$517.35 \div 60 \text{ cu. yds.} = \$8.62$

Total ... $\$517.35 \div 60 \text{ cu. yds.} = \$8.62$
About 2 bbls. of cement were required per 1,000 brick laid, and the cost per 1,000 brick laid was \$517.24.

The cost of superintendence on the work runs about \$50 per day, and repairs, waste and depreciation aggregate about \$40 per day.

In reviewing these figures it must be kept in mind that they omit a number of costs. For example, the cost of lumber for sheeting, runways, etc., and the cost of lumber and construction for centers are not included. Other lacking items will be noted by those familiar with such work. Though incomplete as noted the figures will, we believe, prove decidedly interesting in connection with the novel methods of work adopted.

General Comments.—The methods of bleeding the sand of its surplus water has proved eminently successful. It has enabled sand which normally flows at a slope of 1 on 15 to be excavated in narrow trench to some 22 ft. below water level, with only ordinary rough sheeting and that sheeting not reaching to within 6 ft. of the trench bottom. So important a factor is this bleeding that it is stated by one of the engineers on the work that were the pumping to be stopped for half an hour the trench would become dangerous to work in.

In regard to the pumps it is noted that the vacuum type seems to be particularly successful owing to its ability to work with an access of a large amount of air into the suction and also owing to its ability to handle gritty water.

Engineers and Contractors.—The contractor for the work described is Green & Sons Co., Chicago, Ill., whose superintendent is Mr. R. Shackleton. The engineers are: A. P. Melton, City Engineer, Gary, Ind.; Alvord & Burdick, Chicago, Ill., Consulting and Designing Engineers; W. F. Sargent, Resident Engineer for Al-

vord & Burdick, and E. M. Scheflow, Engineer of Construction.

Incrustation in Water Pipes at Quincy, Ill., and the Cost of Chipping It Out.*

We have had some incrustation experience at our pumping station, which will probably be of interest to all the members of the American Waterworks Association, and especially to those who may have occasion to design sedimentation and filtration systems. Our experience has brought to light serious defects in the construction of our system and it may be the means of preventing similar defects in future installations.

For a thorough comprehension of our trouble a brief description of the plant is necessary. The pumping station is built on the bank of the Mississippi River, from which we secure our supply of water. A Worthington horizontal triple expansion pumping engine, size 12 and 19 and 30x24x21 ins., pumps the raw water from the intake well to the settling basin, which is located upon the hillside about 450 ft. from the pump house and at an elevation of about 40 ft. above the pump. This basin is 70 ft. square and 10 ft. deep. Sulphate of iron and lime are used for coagulating purposes, the iron being drawn through the suction of the Worthington pump and the lime solution being pumped into the discharge pipe by a small auxiliary pump. The discharge from the lime pump was connected with the discharge from the large pump in a valve well just outside the pump house and here appears a serious defect. This arrangement allowed a very thorough mixing of the two solutions with the raw water before they were finally discharged into the basin at a point 400 ft. away.

After a sedimentation period of about one hour in the settling basin, the water flows by gravity through a 20-in. cast iron pipe to the filter house, where the purification process is completed by 14 Continental-Jewell filters. From the clear well under the filters the water flows back to the pump house and into the water chamber of a 5,000,000 gallon Gordon-Maxwell pump, which discharges it directly into the distribution system, the surplus passing into a reservoir of 18,000,000 gallon capacity. This reservoir holds easily a week's supply of water for the city and is located on a hill 230 ft. above the pump house and two and one-half miles away.

The beginning of the serious trouble precedes the date of my connection with the plant and this information is supplied by Mr. F. J. Brinkoetter, who is chief engineer of the pumping station.

During the summer of 1906 the Worthington pump began to show signs of distress. The pressure gauge on this pump

*Reprint of a paper read by W. R. Gilston, Superintendent Citizens' Water Works Co., Quincy, Ill., before the American Water Works Association, with additional cost data furnished us by Mr. Gilston.

should show a head of water of about 47 ft. by actual levels, whereas the gauge was indicating a rapidly increasing head. Investigation of the trouble lead to the discovery of a thick deposit of scale on the inside of the 2-in. discharge pipe. Taps were made at several points along the line of pipe and it was found that the incrustation extended from the point of introduction of the lime solution to the discharge end of the pipe. Mr. Brinkoetter then appealed to Mr. Edward Bartow, director of the Illinois State Water Survey, to find out whether it might be possible to remove the deposit by the use of chemicals. Mr. Bartow came to Quincy and conducted a series of experiments to determine the action of various acids upon the scale and the probable cost of removing it by acid treatment. It was decided that the cheapest and only certain method would be to cut it out with hammer and chisels. Finally, in November, 1906, the storage reservoir was filled and pumping discontinued while the discharge end of the pipe was being cleaned. At the time the pumps were stopped the pressure gauge indicated a head of 100 ft. against which the pump was working.

The first 60 ft. of the pipe lies exposed in the settling basin and was cleaned without difficulty by melting out the middle joint, which allowed three men to work at the same time. Outside the settling basin an excavation was made over every third or fourth joint of pipe which was removed by melting out the spigot end and cutting off the bell end with a diamond pointed chisel. After cleaning, the same pipe was replaced by using a 20-in. sleeve where the bell end was cut away.

A force of eight men worked one week and succeeded in cleaning about 150 ft. of the pipe. The deposit averaged about 5 ins. in thickness and seemed to be about the same through the circumference of the pipe.

It was then necessary to begin pumping again and the pressure gauge showed a reduction of the head of water to 70 ft.

Nothing further was done until July, 1907, when the gauges indicated a steam pressure of 100 lbs. and a head of water of 91 ft. while the pump was running 19 revolutions per minute. Things began to look serious again, so we decided to clean the remainder of the pipe. This end of the pipe was much more difficult to clean because it is crossed by one paved street, in which is a street car track, and by four railroad tracks. A portion of the pipe also lies at a depth of 10 ft., which increased the amount of necessary excavation. The work was begun July 27 and handled in the same manner as before. The pipe was all replaced and ready for use again August 4. A force of from 10 to 14 men was employed and the thickness of the scale increased from nothing at the point where the lime solution was introduced, to 6 ins. at the point where work was begun. At this time 250 ft. of pipe were cleaned, making a total of

400 ft., which was cleaned at a total expense of \$420 for labor and new material used.

After this cleaning the steam gauge stood at 61 lbs. and the water gauge at 47 ft. while the pump was making, 22 revolutions per minute.

In order to obviate the necessity of ever cleaning all of this pipe again, the discharge pipe of the lime solution pump was extended about 300 ft. and made to discharge into the large pipe at a point just outside the wall of the settling basin. This allows a distance of 80 ft. in the large discharge pipe for the mixing of the two solutions before the final discharge into the basin. This 80 ft. of pipe will fill up again and require cleaning, but it will be a comparatively small job. This change in the point of introduction of the lime solution has undoubtedly lessened the efficiency of the basin and thrown more work upon the filters. When the river is very turbid we still use the old discharge opening for the lime pump so as to obtain the best possible results from the basin.

I am advised by Mr. C. R. Henderson, the former superintendent of the plant, that the present arrangement for handling the lime solution was installed early in the year 1902. As the lime is undoubtedly the active agent in the formation of the incrustation it would appear that this scale has been in process of formation only about 5 years, or at an average rate of over 1 in. per year.

During the past winter the gravity flow line leading from the basin to the filters has also become so filled up with the same deposit as to require cleaning.

This line of pipe is of cast iron, 20 ins. in diameter, and it extends from the drop well in the basin 115 ft. along the outside of the north wall of the filter house, then turns a $\frac{1}{4}$ bent and runs 25 ft. along the west wall to a connection with a branch line from the Worthington pump discharge pipe. From this connection the pipe runs under the filter house through a sewer spillway. From this main supply pipe five 10-in. wrought iron risers from 15 to 18 ft. in length extend just above the rims of the filter tanks. These risers are capped by tees from which three 6-in. wrought iron branches supply one filter each. These 6-in. branches are, in turn, reduced to 4 ins. and controlled by butterfly valves.

The deposit in this filter pipe system finally became so serious that we could not get water enough into the filter house to keep all the filters in operation, and the speed of the pumps had to be reduced about two revolutions per minute.

In February, 1908, we discontinued pumping for one week and cleaned a portion of the main supply pipe under the filter house, all of the five risers and the 14 filter branch pipes. This work was done by disconnecting every joint and chiseling out the deposit. Numerous difficulties were encountered. The 14 branch pipes are of wrought

iron connected with screwed joints. These joints could not be disconnected until the thick incrustation on the inside was broken either by an excessive strain on the wrenches or by hammering. Had these joints been made up with flanged unions the labor would have been much reduced. The five 10-in. risers are each in one piece. Their extreme length and great weight when half filled with solid rock, together with the cramped quarters in which they had to be handled, made them almost impossible. They would better be in two sections connected with a flanged union.

The deposit had reduced the inside diameter of the 10-in. risers to about 6 ins. The 4-in. sections just above the butterfly valves were some of them reduced to 2 ins.

The work was done by a force of six men in six days and the cost of labor alone amounted to \$65.

This cleaning resulted in an increase in the filtering capacity of the plant of about 30,000 gallons per hour. The 20-in. supply pipe will soon have to be cleaned also.

During Mr. Henderson's supervision of the plant some cleaning of the filter house piping was necessary and he advised me that plans for a complete rearrangement were being considered at the time of the transfer of the property to the present owners in 1904.

Our experience at Quincy emphasizes the fact that solutions of iron and lime should not be forced together through long lines of pipe. If it is necessary to carry them in the same system, the piping should be so arranged as to be conveniently taken apart for cleaning.

[Mr. Gelston has kindly furnished us with more details of the cost of work done during November, 1906, July, 1907, and February, 1908.

Owing to the fact that the work was in the nature of a rush job, the men were continually changed from one part of the work to another as they were needed, with the result that the cost of the various items of the work could not be easily kept. However, the costs given for the work done in November, 1906, and July, 1907, included the cost of excavation, cleaning the pipes, replacing material used in replacing, back filling and repairing paved street. In cleaning the filter house supply system no excavation was necessary. The cost of superintendence, use of tools, or office work in connection with the pay roll is not included.

The wages paid per hour were as follows:

Foreman.....	30 cts
Caulker.....	20 cts.
Laborers.....	15 cts

The cost of cleaning 150 ft. in November, 1906, and 250 in July, 1907, the costs for material and labor were divided approximately as follows:

4 new sleeves at \$15 each.....	\$ 60.00
800 lbs. lead at \$6.30 per 100 lbs.....	50.40
75 lbs. jute at \$5 per 100 lbs.....	3.75
Sundries—coal, wood, ice, etc.....	9.35

Labor	
Excavating, removing, replacing and backfill	235.00
Labor removing incrustation.....	61.50
Total	\$120.00

In cleaning the filter house supply system in February, 1908, the only new material used was about 500 lbs. of new lead, which cost \$31.50. The labor cost \$33.50, being divided about evenly between removing and replacing the pipe and removing the incrustation.

From the above it would seem that in the larger pipes, with labor at 15 cts. per hour, it cost about 15 cts. a foot to chip out the 5 ins. of incrustation; thus a man chipped a foot per hour.—Editors.]

At the present time there are about 11,182 miles of railroad in operation in Brazil.

According to estimates of the Chinese Customs Service the population of China is 439,211,000.

The average cost of inspection on roads built for the State Highway Department of Pennsylvania has been 3 per cent of the cost of the road, and the average of engineering expenses has been 2 per cent.

An interurban railway at Rockford, Ill., is reported to be cutting the weeds along its right of way by means of an ordinary mower mounted on street car wheels and attached to a street car. The speed at which the mower is operated is about 4 miles per hour.

According to the Canal Record on June 1 the total yardage on the Culebra Division of the Isthmian canal to be removed to complete the cut was 39,655,822. The total estimated yardage for the division is 80,698,248. Of this amount the old French company removed 12,600,000 cu. yds. from 1881 to 1889 inclusive and the new French company removed 10,000,000 cu. yds. from 1895 to May, 1904. Since the American control and up to June 1, 1908, 18,445,426 cu. yds. have been removed, 11,191,488 cu. yds. of which were taken out last year.

The working expenditures for 1907 on the railways of the United Kingdom according to a paper recently issued by the British Board of Trade were as follows:

Maintenance of ways, works,....	
etc.	\$ 51,821,122
Locomotive power	101,873,075
Repairs and renewals of.....	
rolling stock	30,323,161
Traffic expenses	106,235,195
Rates and taxes	23,665,789
Miscellaneous	53,166,512

Total expenditures 373,084,851
The length of the lines was 23,101 miles.

Railway Section

Note: This section is devoted to methods and costs of constructing railways. It will cover road-bed and track construction, contractor's plant and organization, surveying methods and permanent way structures.

Methods and Cost of Mountain Railway Location.*

BY J. J. CRYDERMAN, LOCATING ENGINEER.

This paper will not touch on the economic phase of railway location. While that is a problem we are all cailed upon to solve at some time, yet in such cases it is not as a locating, but as a consulting engineer that we reach the solution.

The real locating engineer is concerned solely in solving the problem of placing given maximum grades and curves between fixed points in such a manner that the cost of construction and operation will each be the absolute minimum. Should he succeed he has emphatically reached the limit of efficiency as a locating engineer.

It is that perfection for which all strive and never attain, but as we realize it, or fail to do so, is our work good or bad.

As the problem of railway location is then the placing of the given line in precisely the right place, this paper deals only with the solution of that problem in relation to mountain work.

In outlining methods for mountain railway location they are not given as either new or novel.

Hundreds of able men have been locating railroads for many years, and the writer does not believe he has evolved anything new and it is with the hope that the discussion of this paper may bring out something better than the best methods of the writer that it is presented.

Kindly bear in mind that the methods given are for mountain location and in many cases would not apply to light practice work. It is impossible to lay down fixed rules for location as each line is a problem to be solved from the data at hand and no two lines are ever alike.

The experience gained on one line helps on all succeeding ones, but it only helps. It does not solve any question except as it enables one by comparison to reach right results. There is no profession where experience and common sense give such profitable results as in railway location.

The first requisite for a successful locating engineer is a good party. However capable any man may be he can only work with the materials at hand and while a good man may secure results with poor tools he could get better results with better tools. Hence the necessity of the best possible party and instruments. Nothing too good can be used.

As to the personnel of the party, the common idea that any one who can turn

and read an angle correctly is a transitman; he who can read a rod and keep a level book a levelman, while as for the topographer, any son of some prominent railway official, who never saw a located line, is competent to take that most important place, and the boy who has done the blue printing at headquarters will answer for draftsman, should be gently but firmly discouraged by the man who finally bears the burden of all their derelictions.

Instead the transitman should be able to successfully take charge of the party in the absence of the locating engineer. The levelman should be capable of running the transit and doing it well, and the rodman should in that case be able to run the level. High priced men? To be sure. Every dollar of extra pay will return ten fold in results, and "after all are not results what the party is sent out for?" The topographer should be able to run either instrument and be a fair draftsman, better yet if at some time he has been a draftsman, for if he has been he will not bring in a book full of weird, wonderful marks that may mean anything except a representation of the country run over. The draftsman should be a rapid and accurate worker, capable of doing fairly neat work and should have had some field experience and if he has had he will be able to either make out the notes turned in to him or be able to call on the field men for such additional data as may be absolutely essential. While not calling for anything that he can calculate in less time than it would take the party to get for him.

As to the rest of the party, it should be made up of the best men obtainable and plenty of them. There is no economy in working short handed.

The writer has found most chief engineers quite willing to furnish a full party, though occasionally one is met like one in the writer's experience. It was on preliminary over an unmapped country, where the writer had to spend an average of two days a week on reconnaissance, making two and three day trips, sleeping out without blankets to be able to cover more country in the given time; cruising trail which the party cut out and built for moving camp; looking after a pack train; buying his own supplies and keeping the accounts; much of the time working short handed, with a transitman sent out from headquarters, who had never seen any mountain work and who had had six months' experience out of school; when the writer received a letter from the chief engineer saying he had noted on the pay roll both a topographer and draftsman, which he

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considered a wholly unnecessary expense, that in his day the topographer and chief of party had done the drafting. As the writer was then averaging 16 hours a day, the topographer 12 and the draftsman 14, he hardly saw his way clear to divide the draftsman's work with the topographer, so kept both, but it gives an idea of the moral support one sometimes gets from headquarters. Though usually the engineer in charge is furnished with all the men asked for, yet, too often, the wages paid are grossly inadequate. Why any man who has worked his way up to the position of chief engineer should try to force wages down is beyond me. Of course we understand that a pay roll presents a real and tangible thing that can be cut down, but why not pay decent salaries on location and cut down the cost of construction? In other words, hire men who can locate a better line that costs less money to build and operate. This does not advocate paying uniform wages nor salaries, but get good men and pay them decent wages, and do not ask them "what is the least money you will take to do this work?" but know what they are worth and pay it.

After a party is organized the writer has a certain amount of discipline in camp and on line.

Seats at table and assignments to tents are made according to rank.

If one wishes to talk shop at meals or at night he wants the men he is talking to near. The writer has found as soon as the men understand the arrangement they prefer it. The writer also believes it pays to let the men know as much about the work as you feel justified in telling. In the writer's experience the men have taken a more intelligent interest in the work and a caution to them not to talk outside of camp has nearly always been sufficient. In a few cases it has not succeeded, but if you cannot trust a crowd of bright, intelligent men, such as comprises the average locating party, you had better get rid of them as soon as you can, for, whether you tell them anything or not, they will talk to outsiders.

In the matter of instruments the writer has used every standard make and many that were not standard and has never yet found the perfect instrument. However, any standard make of mountain transit with stadia wires, full vertical circle, reversible bubble tube and extension tripod all in first-class condition, will answer.

The writer wishes to emphasize these requirements: The transit must be light, compact, and convenient; when a transitman is hanging on the end of a rope 150 ft. long down a 70° slope he does not want any 35-pound transit, nor when it is necessary to give levels or read a vertical angle both backwards and forwards does he want to turn his instrument through 180° to do so. As for an extension tripod: the writer has known good engineers who would not have them, but it seems to him to be the rankest kind of folly. We have

heard men say, "I don't want a transitman who can't set up a stiff tripod anywhere."

The ordinary location party costs from five to ten dollars an hour, and why waste that good money showing ability to do something that does not need to be done. They might as well want a transitman who could set up a transit while standing on his head. No stiff tripods should be made for mountain transits.

For the level any standard make not exceeding an 18-in. will answer, though a 16-in. is better, and there should be at least one extension leg in the tripod, especially if a supported grade line is being run where the levels need to be kept close up to the end of the line. In such cases the levelman must have every show that can be given him.

All the reasons given for a light weight transit apply to the level and will not be repeated. The writer uses a 12 or 13-ft. Philadelphia rod when running a rapid preliminary over a broken country and wanting the levels kept up, and one generally does want them kept up or he wouldn't run the line. Take a light, thin, narrow board five or six feet long, and mark the top plainly as a sort of target then with the rod measure off and mark each half foot down from the top, then measuring with a steel tape place the target mark at some exact even foot above the twelve or thirteen-foot mark on the rod, fastening it on the back of the rod by means of small brads or screws. You now have a 16, 17 or 18-ft. rod, as you may desire, with the top marked to half feet, which answers for intermediate stations and on turns, the levelman reads and sets the target precisely as he would the target on the regular level rod, and you can add from 25% to 50% to the speed of the level party over rough country.

Besides the regular 100-ft. steel tapes always carried I have a 400 or 500 ft. steel tape to use on slopes, using the vertical circle and reducing to horizontal and vertical measurement. When the distance is too great for the tapes, or it is impossible to get them across, use the stadia wires and level rod. Reducing the readings by the table given by Allen or Lavis. For mending tapes the writer prefers the sleeves and solder with the set screw sleeve for temporary repairs. It takes less than three minutes to mend the tape with a piece of candle and the writer has never had one pull apart, and prefers it to the punch and rivets.

For lining rods the best are the wide rods with a line struck down the center, stagger painted. With such a rod, if the transitman can get even a foot of the rod he can plumb it so he knows his tack is where it belongs.

The writer has the rear chainman carry a rod which he uses instead of a plumb bob for chaining; and then uses the rod for helping the axmen keep line. At first the average chainman has to be watched to see that he does not plant the rod on the

ground instead of holding it clear, but he soon gets broken in and it is less bother than a blumb bob and has the advantage spoken of as to keeping the axman on line.

In mountain work, as everything must be packed on horses or men's backs, equipment must be cut to a minimum, and made in convenient form to be packed.

The writer has found a modified form of the sheet iron Klondike stove fairly satisfactory for cooking and they can be packed, and even a heavy form of them can be moved on an aparejos or Humboldt. For tables use the canvas-lath arrangement. For one who has not used them it can be explained that they are made of a strip of canvas of the desired width and length with lath tacked or nailed across them, spaced $\frac{1}{4}$ inches apart, and are unrolled on side poles fixed on posts and covered with oilcloth as with the common plank camp table. They are very light, fairly strong and quite convenient and can be rolled up and packed like a roll of blankets. They can be used for dining table and cook table in the kitchen, and a small section is convenient for the office.

In the way of dishes, use granite ware, but cut them down to the fewest your cook can conveniently get along with, and as that depends on the cook you can make no rule, however, take along two dozen miner's tin cups with open handles and let each man carry his own cup on line for lunch.

Within the past year the writer has experienced the two extremes as to the facility with which supplies can be obtained, or delivered, in one instance being camped beside a trunk railway, and in the other, being in the interior of Alaska. In the one case being able to get everything in the market, and in the other, well, we did not starve, but beans twenty-one times a week grew monotonous; however, the men were as well in one case as the other and seemed to work as well, and some of the same men were in both parties.

In these days with evaporated fruits and vegetables and concentrated extracts it is easier to supply a party fairly well, and still cut the weight to a minimum. In the party this summer the daily weight ran only about 2½ lbs. per man per day, which is about as low as it is possible to get any variety for a party. As it is impossible in a paper of this length to give many details, supply lists of all sorts are omitted, referring any one to the works of E. H. McHenry and F. Lavis for all such information. Merely cautioning any one who has no experience that no two parties ever used the same quantities of any article and that McHenry's parties must have had fearful and wonderful appetites for some things, judging from his supply lists; cod fish and soap for instance; same of list of Lavis. With the McHenry list is supposed to go fresh meat and vegetables and if you are where they cannot be had the evaporated vegetables and sugar must be at least

doubled, and the salt meats increased one half. Fruit and flour will over run.

For office supplies take everything you can and keep within weight limit, using the knock down drafting table and set it up like your kitchen table. The stationery chest should not exceed 12x12x31 ins. in the clear and even then is awkward to pack. Take tin map cases for maps and profiles and when moving camp it is well to roll them in blankets to prevent battering up.

A few simple remedies, but no drug store, are needed. Most of the men carry some favorite remedy for themselves and all needed in the company chest are some pills, sun cholera cure, quinine, some surgeon's needles and sutures in glass tubes, needles and silk thread in envelopes, gauze, rolls of bandages, surgeon's plaster, absorbent cotton, antiseptic tablets and some arnica. The latter is the writer's panacea for all cuts and bruises; one-half teaspoon to a coffee cup of clear water is the best antiseptic the writer has ever used, and any cut thoroughly washed out and sewed up and then kept wet with the mixture will heal without inflammation or suppuration.

If any one in charge of a party has never sewed up a big gash in some man's foot or leg, he had better go to some surgeon of his acquaintance and take a few lessons; he will be apt to get the necessary practice in the mountains.

There should be plenty of room in the tents for the men and they should be supplied with Sibley stoves which can be flat tened out when packed on horses. Men come in wet and cold too often to economize on room and warmth.

Wherever, as in Alaska, mosquitoes are bad, the company should furnish mosquito bars for the men and the engineer should see that they are used, for the man who fights mosquitoes all night cannot work all day.

As any undertaking succeeds in proportion to the attention given to its detail the writer considers the foregoing remarks, as to the party, its personnel and equipment, of the first importance.

After all this introduction we at last come to the active work of preliminary and location with the methods used. Ability or lack of it is shown by the preliminary an engineer runs. Should it not fit closely to the route followed by the location it is time and money thrown away. Do not understand by this that all preliminaries do or should follow such line. Many lines are run where the engineer knows them to be worthless, but he does so to show why the line should not be located on that route. But to run random lines to develop the country shows a lack of ability that should transfer the engineer from locating to some other branch of the profession. Given the proper preliminary with good topography and the final location is a question of mathematics. The skill consists in placing the preliminary not only where the location will go, which any one can do, but where

the location should go, which sometimes is vastly different.

Usually in mountain work the preliminary is for a supported grade line. In such case the writer estimates how much curvature per station he is likely to have (commonly compensating .01 per degree of central angle) and then reduces it to a uniform grade per station. For example we are running a 1% grade compensated .01 per degree, we judge we will have equal to a continuous 5° curve, or a compensation of .2 per station or equal to a straight 0.8% grade. Now make out a table of grades for 0.8% for the use of the transitman and levelman so they can tell just how they are for grade whether the engineer is with them or not. Each night the line is platted up and a rough projection made, and the compensation figured to the end of the line and the trial grades corrected up. After the second day the topography is platted and the projection made more carefully and the grades rechecked and carried ahead to the end of line on rough projection. By this means the preliminary should be almost where the located line should run and the topography should cover the country desired.

As to methods of field work on preliminaries, there is really little difference between the general run of engineers. With the writer the transit notes are kept in the usual way except that he always has the magnetic courses taken and recorded. It hardly ever checks with the angle, but if cut over 1° the angle is rechecked, and it will always save the transitman from making any serious errors in angle, though the writer has had men who made the same error in reading their angle and checking the course. The writer uses a hand level, or clinometer, and directs the head chainman, dodging obstacles as much as possible, and still keeping as near grade as can be done. In cases of deep cuts, high trestles, or tunnels, follow grade around them, then run a line where the located line must go. This for the topography and for the reason previously given, to show why the line must go where it does.

The levels are kept up as closely as they can be, and the levelman leaves the elevation of stations and angle points for the topographer, usually on a stake or piece of paper, every 100 or 500 ft.

The writer tries to have the topography kept right up to the work so that the draftsman is only one day behind and the projection can be kept up.

When leaving the party to be gone over an hour, the transitman is called to take the place of the engineer and the levelman runs the transit, for no man can run a party while standing behind a transit.

In speaking of the levelman running transit reference is made to the ideal party. The writer has had the rear chainman run transit and he did good work too, but some one must be ahead and some one must run transit. The principal thing is to get it done and done right.

Having the elevation of the station and angle points the topographer, where he can, locates the 10 ft. contour above and below the line, and then takes the ground by slope measurement and distance, using a clinometer, measuring the distance with rod or tape where he can, estimating distances where he cannot measure; besides entering these notes in his book he also sketches in the general features of the line showing stream and gulch crossings with their course or angle to the line, also character of the country and any other information he can secure.

In reducing the topography to the map the writer uses a piece of celluloid about 6x12 ins., out of which are cut slits running across about $\frac{1}{8}$ in. wide and $1\frac{1}{2}$ ins. long, reaching to within $\frac{1}{4}$ in. of the edge. On the edge of these slits are marked foot contour intervals, with the 5 and 10 ft. prominently shown, for each degree of slope up to 20°. Then by 5 and 10 ft. contours and for each 2 or 3 degrees of slope up to 35°, then by 5° intervals up to 60°.

The one the writer uses is on a scale of 200 ft. to the inch and can be used for the 100 or 400 ft. maps, by interpolating values. Any draftsman can use it at once and they are a very convenient labor saving device. The writer has not mentioned locating the contours on the ground and entering them in the book, as it is generally out of the question. The preliminary map is generally made on the 400 ft. scale, as it is most convenient, and on this the writer lays his trial location. Taking the table of grades worked out from the rough projection step off 500 ft. with hair spring dividers set as carefully as possible following direction of the probable location and marking grade in pencil with a rivet pen, carrying these grades if possible for at least a mile of line. Now at a glance you have your grade line; some men connect their points by a dotted line, but the writer has never found it necessary; now try for the best line possible for the ground, as one should always try first for the best possible line, later trying to cheapen where it can be done, or more truthfully, where it must be done.

For projection the writer uses thin celluloid curves, which he cuts out of a sheet of celluloid with a beam compass, as the manufactured ones are both bulky and expensive, and a dollar's worth of celluloid and a half day's time will furnish a set.

The set the writer now uses is for the curves he uses most, as, like most locaters, he has favorite curves whose deflections are easy to figure, and whenever they will fit the ground they are used. The set mentioned is for a scale of 100 ft., but they can be used for any scale by interpolating values. Whether to lay the tangent and fit in the curves, or lay the curves and connect by tangents depends on the ground. Commonly both methods are used on the same sheet. In either case the tangents are drawn to intersect the meridian on the map and the courses are taken by scaling tangent distances from intersection of meridi-

an and taking the course from the tables of natural tangents, in the same way you would plat from tangents. The courses are marked on the tangents and the angles computed by differences in courses.

Incidentally the writer might here remark that all his maps are platted by latitude and departures, and in the office copy of the field notes the co-ordinates to each angle point are recorded; the transitman calculating the traverse of his line, being checked by the draftsman, or on rainy days by other members of the party. The angles on the map are roughly checked by a protractor. The projected tangents are scaled from apex to apex and the tangents for the curves are taken directly from Butts' Field Book. On each curve is marked degree of curve, central angle, semi-tangent and length of arc, and it is penciled in on the map. Now for stationing scale distance to P. C. of first curve, P. C. plus arc equals P. T. Then apex distance minus semi-tangent of curves 1 and 2 equal tangent length between curves, P. T. plus tangent length equals P. C. of curve No. 2 and so on. Now use stepping dividers and lay off stations, checking by the P. C.'s and P. T.'s on line. While stepping line take off your trial profile; usually you see at a glance the line must be shifted, which you do at once, rechecking your angles and stationing and continue till you get a line that looks about right. Now using your table of grades lay a temporary grade line and make a preliminary estimate, using a table of cutting on transverse slopes. You will almost always find your line must now be shifted once more. In doing all this use a soft pencil with as fine a point as possible, and even then the map looks disgraceful, but it does not look any worse than you feel after you have worked over it awhile. When you have exhausted yourself and the map, you are ready to run in the line; but the writer only calls and uses it as a trial location, not marking the stakes L, but any letter not previously used, and not running in nor using spirals.

This line as run in is platted on the preliminary map, also on a new map of 200 ft. to the inch, and in very bad country 100 ft. to the inch. As the line is run in, co-ordinates are figured to the apex of each curve and ties are calculated and made to the preliminary at frequent intervals. The writer does not run tangents to intersections, as he does not think the value equal to the work required, but depends on ties to the preliminary to take its place. On this work the writer has a small tracing showing a mile or so of the projected line and preliminary with the ties, showing some topography, but not much. The writer carries in a book bag a thin board, 8x12, smoothed on one side, some thumb tacks, a small protractor which has been checked and is known to be accurate, a small triangle, a 6-in. pocket scale in case and a pair of pocket dividers, also some loose sheets of scratch paper tacked on the board. If the projected line does not fit use this small

drawing outfit and tracing and project a line that does fit.

Sometimes but not often the writer backs up, sometimes makes offsets. In fact what is done with the line depends on what can be shown by levels and topography. If to get them we must back up we do so, if not we go ahead. On this trial location the levels are checked with the preliminary, as are the courses of the transit lines. The topography is taken with as much care as possible and platted on the new map, but no effort is made to try and fit it to the preliminary map.

On the new map is now projected the revised location using some of the methods used on the first projection, but with many modifications. This time, instead of carrying the tangents to meridians and scaling them for the course, latitude and departures of the apex points are scaled from the meridian, entering the co-ordinates on a traverse sheet. From these are found the latitude and departures for each course and from these are worked out courses and distances. In other words, it is the traverse of the projected line worked backwards, and by frequently using some course or apex of the trial location the work is checked and rarely is out more than 5 minutes on courses. On the revision, spirals are calculated for all curves exceeding 3°, and unless on some road that insists on some other the writer always uses Talbot's, as it is the simplest and most flexible of all

In running in curves in brush the writer uses long chords and offsets the stations. It means watching the chainmen to see they hold off the correction. The table of long chords given in Shunk's Field Book is usually correct to within 2 tenths up to 400 ft. for 6° curves, and it saves calculating them.

Some engineers object to offsetting stations on curves, but all the use you have for them in brush is for levels, topography and clearing, as the line must be rerun for cross sectioning, and the man who cannot get them close enough for purposes mentioned had better try some other work. Personally the writer has never felt called upon to slash the right of way to set a few stakes, and for that matter many stakes must be left unset in the mountains, the best you can do, and left for the construction parties, who have both more time and ropes than the location parties. The writer has found where there has been nothing to tie the lines to that it is well to take an observation on Polaris about every 10 or 15 miles. It corrects up the courses and catches an occasional error in courses that has slipped by.

On the work the writer carries a transit book in which are put all sorts of notes regarding the line, but for which the principal use is to keep alignment, grades and classification of materials.

From the note book for this summer, for instance, the following examples are given:

	Calculated courses.	Apex distances.
	S 33° 22' W	600
(C=16° R.		
(D=39° 30'		
(T=139°		
(A=240.9		
	S 72° 52' W.	645
(C 12° L.		
(D 35° 18'		
(T 152.2		
(A 294.2		
	S 37° 34' W.	716.

spirals. The writer also runs the spirals in on the revised locations, as it is the only way to secure the profile of the true line.

Some good engineers do not use spirals on location, but leave them for the construction parties, but the profile is incorrect and of course the estimate also. Besides when left it means an equation at the end of every curve, a thing every engineer abhors. Where there is an equation it should be carried to a tangent and then only marked on map and profile, short or long station giving the length. If there is anything detestible it is to find a profile marked 139+40 equals 138+72 and to the end of time one will wonder whether the man lost a station or found one.

The method used in running in the revision is much the same as on the trial location.

and on opposite page of book, opposite curve No. 37 is entered "Tangent between curves 36-37, 25 ft. too far down hill"; opposite C No. 38, "Curve too low, narrow shelf 15 ft. up from line, where curve should lie."

On classification is entered:

C=Curve.

D=Central angle.

T=Semi-tangent.

A=Arc.

All curves are numbered beginning at 1 and carried through, compound curves being called one curve when numbering.

An example of a note book entry for classification of material is shown below and on opposite page is entered notes such as trestle, width, length and character, culverts with size, snow sheds, clearing and grubbing, riprap, retaining walls, and in

CLASSIFICATION OF MATERIAL.						
From Sta.	To Sta.	Solid rock.	Loose rock.	Hard-pan.	Earth.	
185	202 Emb.		50%		50%	Fair sized spruce.
202	206 Exc.			100%		Small spruce.
206	230 Exc.	80%	20%			Very small timber.
230	241 Exc.			60%	10%	Some burned, some fair sized spruce.
241	259 Exc.				100%	Sta. 257, 60 ft. trestle.
259	267 Exc.		100%			

fact all the information needed to place on the profile. Most writers recommend taking the finished profile and going over the line, placing all this information on it. The writer wonders how many locaters ever get the time to do so. Here is one who certainly never has.

Having the revised profile the estimate is carefully worked out and entered on it by miles showing a complete estimate of all quantities with classification.

For the profile, follow the Northern Pacific sample profile, but showing the alignment by curves instead of angles, also marking on each curve R and L as the case may be, and on the map showing all information possible. For the estimate sheet use a modified form of the one given in Lavis' "Railway Location and Estimates," but only using the one for miles and not the one for stations.

Also on the same sheet, which is made in sections of from 20 to 25 miles, show in tabulated form the average cost per mile, giving every item with unit prices of each.

Also length of solid road bed.

Length of trestles and bridges.

Percentage of each.

Number of curves of each degree with total degrees of central angles.

Maximum curves and grades.

Total rise and fall, in fact all possible information that can be shown in tabulated form should be shown on this sheet.

In case of running alternate lines the cost of every item should be shown by comparison as well as grades, rise and fall, curvature, length, in fact all the information that can help to give a clear conception of the relative cost and values of the two lines.

For the office copy of field notes use this form which takes up both pages of a field book:

miles in one locality would be poor in another.

In 1903, from March to September inclusive, the writer ran 140 miles of preliminary at a total cost of \$10,500, costing an average of \$75 per mile. This included all expenses of every kind, including transportation for a full party and outfit from Bellingham, Washington, to Brewster, Washington, on the Columbia River, and the return of the party from Ruby Creek, a branch of the Skagit, to Bellingham. Besides the line run, but included in the cost, was the building of 20 miles of trail by the party in the Cascades, a pack train, move of the camp and outfit of 70 miles (requiring one week on account of rain and snow) to cover a gap 4 miles between the end of trail being built and the one building, as to construct the 4 miles would have taken 30 men six weeks with a half ton of powder.

Also two months of extra work of the writer and draftsman completing all data in regard to the line.

As a basis for comparing costs the following list of salaries is given:

	Per Month.
Transitman	\$ 90.00
Draftsman	85.00
Levelman and topographer.....	75.00
Rodman and head chainman.....	45.00
All other men, except cook.....	40.00
Cook	75.00
4 horse team and driver, 2 months..	125.00
Feed for team and board of driver.	
Pack train, 20 horses, 5 months, per month	150.00
Packer, per month.....	75.00
Packer's helper, per month.....	50.00

The company shod horses in pack train and furnished feed when required.

As the writer has not been home since starting this paper he is unable to further

In 1906 the writer reran a portion of the location of the Washington & Great Northern from Wenatchee to Oroville. The work was revision of location as covered in the description of projection and running in of such work. There cannot be given so close a statement on this, but will say that the average was 25 miles of location per month at a cost of \$62 per mile, wages being about the same as given above.

The above examples show how worthless for purposes of comparison tables purporting to give cost per mile of surveys can be, preliminary within 100 miles costing much more than location.

It would be shocking were it not that the same man did both, and both parties were equally good. As a further example, without going into details, will say that the cost per mile of preliminary and location this season on Copper River, Alaska, will run over \$350 per mile, and in the Alaska work on location the average was 8 miles per month, as against 25 on the Columbia and in Alaska a pack train of 4 horses costs \$800 per month.

The real basis of comparison is for like work done under like circumstances, though that is hardly a possible condition.

The subject of mountain location has hardly been outlined in this paper and every locating engineer will note the numberless omissions, but after all it is so much easier to do a thing than to tell some one else how it is done.

The U. S. Civil Service Commission, Washington, D. C., will hold an examination on Sept 2, at various cities throughout the country to secure eligibles from which to make certification to fill vacancies as they may occur in the position of engineer in wood preservation (male), in the Forest Service Department of Agriculture, at an entrance salary of \$1,000 per annum. It is anticipated by the Department that about eight vacancies will be filled as the result of this examination.

Bids are now being asked by the Board of Water Supply of New York City for the construction of another section of the Catskill aqueduct. The work calls for the construction of a 3-mile stretch of plain concrete conduit known as cut-and-cover aqueduct, 17 ft. high by 17½ ft. wide inside.

ALIGNMENT: REVISED LOCATION.

Curve No.	Stations.	Markers.	Degree of Curve.	R	Spirals.		Central Angles.		Total.	Length of Curves.		Length of Tangents.	Apex Distance.
					Δ	L	Spirals.	Chordal Curve.		Spiral.	Chordal Curve.		
64	520 + 72°	P. T.											
	526 + 66	P. S.											
	528 + 66	P. C.	10° L.	5	10° 00'	2.0	10° 00'	30 34'	50 34'	200	305.7	593.4	N79°28' W 1320.3
	531 + 71°	E. C.											
	533 + 71°	P. T.											
Latitudes, departures and co-ordinates to apex of curve shown on opposite page.													

The amount of work that can be done by a party depends on the character of the country and the kind of line run. What might be a fair season's work expressed in

segregate the item of expense on the work, though he has it filed away, divided into about nine or ten headings, but the total amount and time is as here given.

approximately between Ireland Corners and New Hurley, in the towns of Gardiner, Plattkill and Shawangunk, Ulster County, N. Y.

Bridges, Buildings and Foundations

Note: This section is devoted to methods and costs of constructing steel and masonry bridges and buildings and of foundation work of all kinds. It will give special attention to erection plant and tools, falseworks and centers and cost data of all kinds.

A Modern Storage Warehouse for Iron and Steel Products.

The accompanying engravings show typical views in the iron and steel warehouse of Jos. T. Ryerson & Son at Chicago. This warehouse exclusive of office room has a floor space of 675,000 sq. ft., and is the largest storage for iron and steel in the United States. The business of the firm may be described as a department store for iron and steel, and it is the firm's pride that any reasonable demand for manufactured iron and steel can be filled promptly from stock. As a distinctive feature of the iron and steel trade in America and a feature which is designed to add to the convenience of the ordinary purchaser, we be-

lieve that many of our readers will be interested in the information which follows:

The present plant had its inception in 1901, and its floor space amounts to 675,000 sq. ft., exclusive of the offices, and provides a stocking capacity of 150,000 tons. The two main buildings are separated by Sixteenth street, but are connected by means of a tunnel passing under the roadway. They are of practically equal ground area and both are of heavy steel construction. The ground floor is built of heavy planking laid over beams imbedded in concrete. The upper floors are designed for a load of 700 lbs. per sq. ft.

The structural steel warehouse is about 500 ft. square, arranged in six longitudinal bays. Of these bays the one used as the beam yard is 110 ft. wide, the adjoining bay to the north is 75 ft. wide, two others are 65 ft. wide and the smallest are 45 ft. wide. The building is inclosed, roof and sides, with corrugated iron. The roof trusses are of simple design and are carried on lattice-steel columns. The columns carry crane runways in each bay and each runway is provided with two cranes. The cranes of widest span have a trussed frame and are of 10 tons capacity. In the 75-ft. bay the cranes have an I beam runner hung from the bridge, the runner carrying two trolley hoists, each of five tons capacity. The cranes of smaller span in the remaining bays are of similar design and capacity. The handling of material is very rapid, the cranes having a speed along the runways of 350 ft. per minute and a trolley speed across the crane bridge of 175 per minute. The clearance under the cranes is about 20 ft. and with a normal volume of material in stock the trolleys just clear the piles of steel. By means of this system of

13 to 20 seconds. Shapes coming to the saws are fed by motor-driven roller tables, which run transversely of the building, so that material from any part of the floor may be brought to these tables by the cranes and fed to the saw. Heavy shearing and other tools for turning out the steel in just the form desired are located conveniently in various parts of the warehouse and, in short, facilities are provided for all of the buyer's requirements. One portion of the floor, centrally located, is reserved for the storing of short ends. Here parallel beams are set in the floor 5 ft. apart. When the standard length shapes are cut the crop ends are piled on these beams and when a future order is filled which calls for some short pieces the stock of short ends is first inspected, and at a glance the approximate length of any piece in this stock can be seen from the beam spacing. Classifications of the various shapes are followed according to the section sizes. The small tools and repair parts are kept in an inclosed room centrally located in the warehouse.

The buildings last to be completed in-

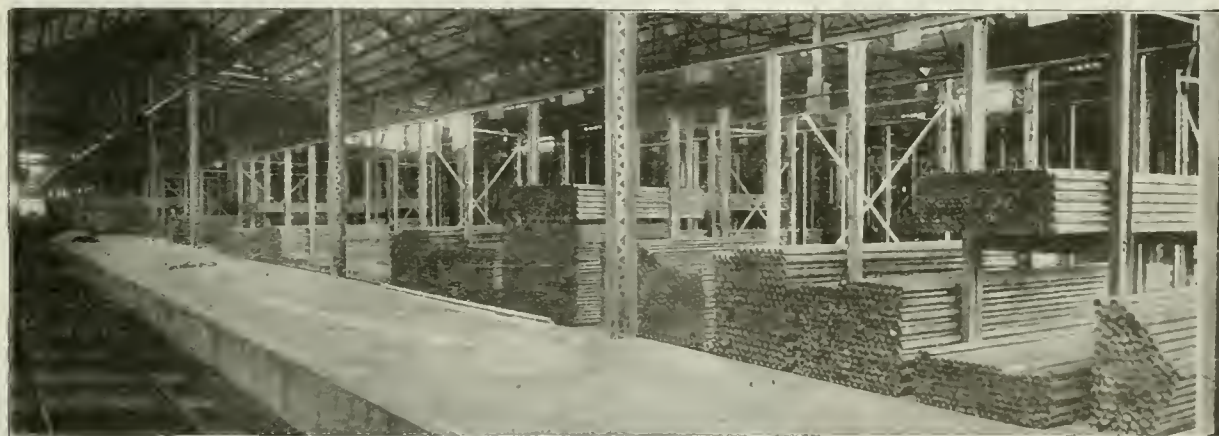


Fig. 1—View of Tube Floor, Showing Method of Piling Tubes.

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steel columns and with the added service of two wall jib cranes the entire floor of this warehouse is covered with ease and speed. Railroad tracks traverse the warehouse at the extreme east end of the building next to the wall and at right angles to the cranes. Cars on these tracks may be loaded and unloaded directly by the cranes in each of the bays. For team haulage a wagon driveway is provided parallel to these tracks with the same facilities for loading and unloading as is possible to the railroad. At other points in the building access may also be had with wagon and team.

All standard sizes and shapes are kept in stock, conveniently assorted, from the lightest to the heaviest sections. The equipment for preparing this structural material to conform with all varieties of consumers' specifications either regular or special, is very complete. It includes three Ryerson friction saws. These saws are of heavy construction and are capable of cutting a 24-in., 100-lb. I-beam section in from

clude the office building, on two floors of which are also stored sheets and rivets, the plate, bar and hoop warehouse, the warehouses for storing tubes, galvanized sheets, machinery and heavy tools, and the various specialties, about 1,100 in number. The combined area covered by these buildings is 415x596 ft. The office building occupies one corner and is three stories high. The plate and bar warehouse is a continuation of this building and is of the same type of construction, but instead of three floors the same height is given to two floors, which permits of ample head room for storing the bars on end and also for manipulating the system of trolley service installed overhead on the plate and bar floors. The balance of the adjoining warehouses is but one story high, but of the same height to the top of the columns as the bar warehouse, so that in reality a height equivalent to one and one-half stories is obtained, to which is added the space under the gable roofs. The roof of the office building is of

sawtooth design of ordinary construction, the balance of the building being covered with roofing tile. As indicated in the illustrations the buildings are brick walled and of an architectural design unusually attractive for this class of structures

Placed at the rear of the shipping platform are plate and sheet shears.

There are also installed in the warehouse four guillotine plate shears, one of which, manufactured by Hilles & Jones, weighs 260,000 lbs., and has capacity for cutting 12

which this is a part, the latticed columns and roof trusses, the style of roof and the lighting arrangement. It will also be noted that while no crane is installed in this bay, the brackets for supporting the runway are in place for the future installation of crane



Fig. 2—View Showing Galvanized Sheet Department and Part of Separating Partition.

The offices are confined to the third floor of the building and are reached by elevator and stairway, both from the front entrance to the building and from the warehouse.

Directly underneath the office, on the second floor and occupying like floor space, is the storage for high grade and special sheets of all sizes. These are handled by truck to a freight elevator which serves the floor and by which they may be lowered to the shipping floor immediately below. This floor is inclosed and adequate precaution taken for the protection of the sheets.

On the ground floor below is located a storage for rivets, shipping platform for teams, shipping office and teamsters' room. The rivets are kept in kegs which are arranged in stalls according to sizes, and are handled for shipment by means of hand trucks to the adjacent shipping floor. This shipping platform, because of its equipment and arrangement, is one of the important features of the plant. Material from any part of the warehouses can be brought to it by trolley, crane or elevator. Serving the floor itself are four three-ton Sprague electric hoists, operated by hand chains, extend the length of the floor from underneath the warehouse cranes in the rear to the entrance from the street. One crane is located in each of the four bays comprising the platform. Each bay is provided with floor scales and the floor is unobstructed to permit of heavy teams driving in from the street and maneuvering within the building.

ft. of 2-in. steel at one stroke. This is the largest machine of its type ever built.

The teamsters' room, where they may wait while their load is being handled, is adjacent to the shipping floor and is a part of the general wagon shipping office. The

service, which provision applies as well to all other bays in the warehouse in which cranes are not already operating. An arrangement used here and elsewhere in the warehouse, for increasing the number of separations of sizes upon a given floor



Fig. 3—View Showing Floor for Storage of High Grade Steel.

furnishings of this shipping office are similar to those of the general offices.

Immediately back of the above section are stored the galvanized sheets, this department being shown in Fig. 2. This view also shows the lighter steel construction of the one-story portion of the warehouses, of

space, consists of platforms built of channel steel and standing at a height of five or six feet. This permits of storing material, under and upon the platforms, of two different classes.

Fig. 2 also shows a part of the partition which separates from the sheet floor the

room in which the machine tools are displayed. This room is of such a height as to leave sufficient clearance between its roof and the roof trusses of the warehouse for the operation of a 15-ton crane which travels throughout the length of this bay. The middle panel in the metal roof of this machine room is removable and with this arrangement machines may be lifted in and out of the machine display room by means of the crane and be transferred to the adjacent wagon platform or railroad car with little difficulty.

The remainder of the warehouse, east of the middle crane bay, is devoted to the storage of bars, hoops and tubes on the ground floor, and above the bar floor to the storage of plates. The building is of very heavy steel construction, with solid built-up section columns and I-beam floor girders. The bars stand on end, supported by racks between the columns, and are handled on trucks and by means of trolleys. The aisles are electrically lighted. The bar floor, together with the plate floor above, has over 100,000 sq. ft. of storage space and provides for the carrying of 740 different bar sizes.

The plate floor, Fig. 3, is arranged in bays in which the plates are classified according to quality and size. The plates are piled flat on the floor to prevent distortion and are carried in over 600 sizes. This floor is also electrically lighted along each row of plates. The tube floor adjoins the bar stock. The tubes are piled, by sizes, in racks or booths built of channel iron, as shown in the view of this floor, Fig. 1. Metal signs, on which are painted the size of tubes in each booth, are hung from the framework.

One of the features of interest in this warehouse are the facilities for internal transportation and for handling material. As in the south warehouse, the east end of this building is traversed by a railroad spur. These switches provide direct connection with the Pittsburg, Cincinnati, Chicago & St. Louis railroad, the Chicago, Burlington & Quincy and the Terminal Transfer, and there is sufficient trackage within the warehouse to permit of loading or unloading 49 cars under the warehouse roofs simultaneously.

For handling material within the north warehouse are two crane bays, the one in the middle, mentioned above, and the extreme end bay, in which are also the railroad spurs. The plate floor does not extend over to the east wall, which allows for the installation of a crane directly over the railroad cars on track. In both of the crane bays there are two runways, one for a first floor crane and the upper one for the second floor. Two cranes are installed on each runway. The cranes, of a type built by the Case Mfg. Co., Columbus, are of 10 and 5 tons capacity and their hoists are trolleys independent of the crane and operating on I-beam runners.

The recorded cut of lumber in 1907 in the U. S. in M. ft. B. U. was 40,256,154.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

LETTERS TO THE EDITORS.

A Suggestion to Manufacturers Publishing Trade Catalogs.

Sirs: I have noticed with a great deal of interest the series of editorials and letters on advertising that have been running in your paper recently.

There is one thing that I think has been overlooked, that is the use of insert sheets for the engineers and contractors' pocket-book or notebook. I think that these sheets should contain condensed diagrams, tables, rules, formulas, etc., that would be of permanent value to the owner. The

out it or try to remember to look it up when I get in, whereas if I had an insert sheet I would slip it in my pocket book and almost always have it with me.

I think that this could be made one of the most useful systems of advertising to the Engineer and Contractor and one of the most profitable to the firm who advertises this way as their advertisement would always be in view.

Respectfully yours,

Pomona, Cal., CHAS. KIRBY FOX.

[Mr. Fox incloses with this a sample insert sheet, measuring 7½x11 ins., one side of which we reproduce. See Fig. 1. This

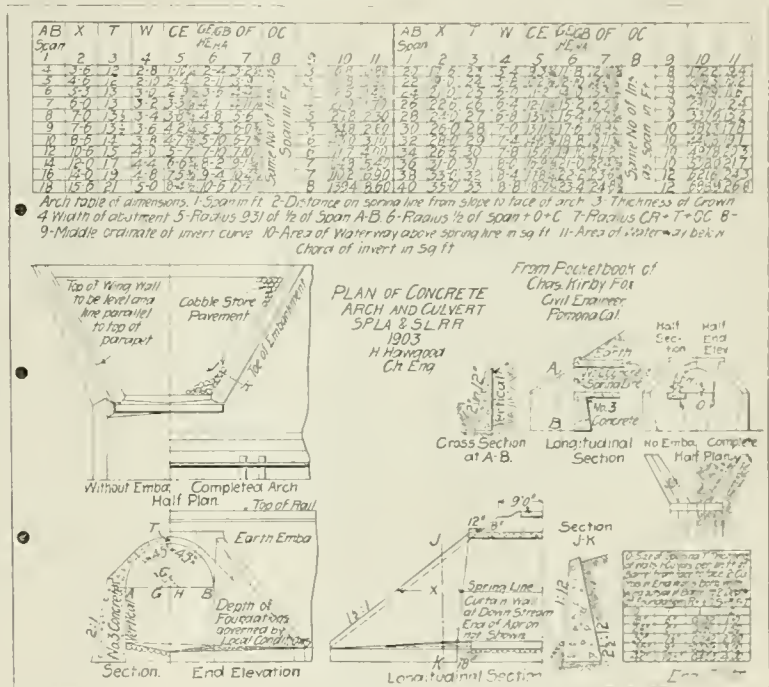


Fig. 1—Sample Insert Sheet.

information could be in reference to some of the firm's products or some information of general use, with a small, neat advertisement in one corner. As an illustration, I herewith inclose a sketch and tables of concrete arches and culverts, a waterway table and some formulas, etc.

I have a loose-leaf book that measures 6¼x8¼x1¼ ins. outside. It is leather bound and has three rings, 2¾ ins. apart. I usually use sheets from 5x7¾ to 5¼x8½ ins. in size or inserts that will fold to about this size.

When I get a catalog I look it over and file it away to have it to refer to in the future. When in the field many times I want some of the data given in one of the bulky books or catalogs which I do not happen to have with me. Result, I go with-

has much valuable information on it regarding concrete arch culverts. On the reverse side is a table showing approximate areas of waterways needed for various drainage areas, and space left on this side of the sheet for an advertisement to be printed. This sheet is folded to a 6x7½-in. size and the advertisement faces up, being placed in the pocket book in this position.

Mr. Fox's suggestion has many features to commend it to manufacturers carrying on a campaign of advertising. Such insert sheets would not be thrown into the waste basket, nor would they be filed away to be referred to at long intervals, but by the method suggested, the advertisement would be brought to the daily attention of the user, and the advertiser's name and his products would be impressed on the mind

of the engineer and contractor. Engineers and contractors have learned the value of collecting such data for ready reference, and in many cases manufacturers of tools and machines are in a position to furnish much valuable information that cannot be obtained elsewhere.—Ers.]

The Cost of Engineering in City Work.

In his annual report for 1906 Mr. Louis C. Kelsey, city engineer of Salt Lake City, Utah, gives the cost of various work done by his department and it is so listed as to show the cost of the engineering work and supervision, also the cost of inspection. Mr. Kelsey was not in charge of the engineering department during 1904-1905. He was the city engineer in 1901-1903, coming into office again in 1906.

Most of the work has been done by contract, and can be grouped under several heads, as water works, sewers, street work, etc.

WATER WORKS.

Water Mains.—In laying 49,003 lin. ft. of 6, 8 and 10 in. water mains, the majority of them being 6-in. mains, the costs were as follows:

Total cost.....	\$75,702.25	100%
Engineering	1,771.41	2.3%
Inspection	1,028.99	1.4%

Water Conduit.—This is known as the Big Cottonwood Conduit. This conduit is built of concrete and is about 7 miles long, the extreme width inside is 3½ ft. and it is 4 ft. high inside, being rectangular in shape. The method of construction called for building the side walls first, which were allowed to set. The forms were removed and bottom constructed between the side walls. The floor was then allowed to set four days or more before building the roof. This method was changed so that the forms were placed to give an entirely monolithic construction of the conduit. In addition to the conduit, a small dam and head works were built, and some improvements were made to the old storage reservoir. The cost was:

Total cost.....	\$411,669.02	100%
Engineering	24,791.10	6%
Inspection	4,140.96	1%

Jordan and Salt Lake City Canal Con-

duct.—There were 1,083 lin. ft. of this conduit built of reinforced concrete and 4,350 lin. ft. of brick. The cost of this work was:

Total cost.....	\$31,198.32	100%
Engineering	1,026.43	3.2%
Inspection	587.99	1.9%

Warm Springs Pipe Line.—Cost:

Total cost.....	\$1,598.92	100%
Engineering	146.05	9%

Liberty Park Wells.—Liberty Park is one of the recreation places of the city. A 12

SEWERS.

Sewer Extensions.—In laying 70,329 lin. ft. of 8, 10 and 12 in. sewer pipes, the majority of which were 8 in., the cost was:

Total cost.....	\$84,860.24	100%
Engineering	3,528.09	4.3%
Inspection	2,637.01	3.1%

Gravity Outlet Sewer.—This sewer was 5,920 ft. long, the construction of it lasting through several years. The cost was:

Total cost.....	\$33,428.48	100%
Engineering	1,439.71	4.3%
Inspection	654.38	2%

Main Intercepting Sewer.—This is a 15 and 18 in. sewer and is not yet finished. The estimated cost is \$137,640.50. The cost of work done is:

Total cost.....	\$17,909.61	100%
Engineering	2,879.02	16%
Inspection	448.12	2.5%

Closets in Liberty Park.—Two brick closets without cesspools were built in Liberty Park. The cost was:

Total cost.....	\$3,169.62	100%
Engineering	60.15	2%
Inspection	96.37	3%

STREET AND ROAD WORK.

Street Paving.—The pavements consist of asphalt, stone block and macadam. Of new work 8,288 lin. ft. of street were paved and 3,720 sq. yds. of asphalt repaired. The cost was:

Total cost.....	\$168,715.94	100%
Engineering	4,876.38	3%
Inspection	1,778.23	1%

Curb and Gutter.—All concrete curb and gutters are used for new work. The cost of laying 6,016 lin. ft. was:

Total cost.....	\$8,961.42	100%
Engineering	458.32	5%
Inspection	130.50	1.4%

Sidewalks.—The sidewalks are of cement, being 4 and 6 ins. thick. In all 209,986 lin.

crosswalk and there relaid, 6 ft. wide, across the street. The work was done by contract on a square yard basis, including the hauling of the stone within a mile, over haul being allowed for distances exceeding a mile. The cost was:

Total cost.....	\$2,230.80	100%
Engineering	97.68	4.4%
Inspection	13.12	2%

Building Steps.—The cost of building some steps was:

Total cost.....	\$2,808.02	100%
Engineering	25.15	1%

Breaking Down Rock in Quarry.—This work done by contract cost as follows:

Total cost.....	\$1,492.01	100%
Engineering	6.70	½%

Hauling Rock and Gravel.—A contract was made with the electric railway company to haul stone and gravel at the rate of 25 cts. per cu. yd. for the first mile or fraction thereof, and for each additional mile or fraction 5 cts. per cu. yd. In all 5,406 cu. yds. have been hauled at an average rate of 35.3 cts. per cu. yd. The cost was:

Total cost.....	\$1,940.14	100%
Engineering	9.90	½%

Concrete Culvert.—A concrete arch culvert built under a roadway cost:

Total cost.....	\$203.83	100%
Engineering	14.80	14%
Inspection	21.00	2.6%

ENGINEERING ORGANIZATION.

The engineering corps of the city is made up as follows: The chief engineer has under him a principal assistant engineer in charge of water works, with 7 assistants; an assistant engineer in charge of the street division, with 17 assistants; an assistant engineer in charge of sewer construction, with 8 assistants and 5 men in charge of operating sewers; an assistant engineer and 3 assistants in charge of private surveys; a chief draftsman and chief computer and 22 assistants of various kinds in the office; 3 stream gages, and an assistant engineer and a cement tester and a cement sampler in the inspection division.

TOTAL COST OF ENGINEERING.

During the past six years the total cost of contract work with the cost of engineering and the cost of the engineering department were as follows:

	1901.	1902.	1903.	1904.	1905.	1906.	Total for six years.
Cost of construction work.....	\$115,893.01	\$342,993.99	\$125,338.38	\$241,875.99	\$441,651.46	\$865,477.92	\$2,133,230.75
Cost of engineering	5,155.37	9,665.53	5,709.00	8,216.95	35,011.89	27,998.32	91,757.06
Cost of engineering department..	19,697.63	25,486.61	26,273.62	34,743.62	65,945.64	65,030.91	237,178.03
Per cent of cost for engineering....	4.80%	2.94%	4.98%	3.62%	8.85%	3.45%	4.79%

ft. were laid, amounting to 1,376,381 sq. ft. The cost was:

Total cost.....	\$223,705.84	100%
Engineering	11,600.80	4.2%
Inspection	3,458.93	1.5%

Stone Block Crosswalks.—During the year 3,000 sq. yds. of stone block crosswalks were laid. On streets where paving improvements are being made all the stone blocks were carefully removed and piled at the side of the street. Later they were hauled away to the site of the proposed

From this it would appear that 5 per cent is an ample allowance for the cost of engineering on work done by a city engineer. In the table we have included the cost of conducting the engineering department, to show that the cost of engineering supervision and work in connection with new construction is much less than one-half of the total cost of operating the engineering department, the work of maintenance and operation costing more than planing, staking out and supervising new construction.

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are: First, to inform civil engineers and contractors of the articles and papers of merit that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.
American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.
American Engineer and R. R. Journal (Am. Engr. & R. R. J.), New York, N. Y.; m; 7x10 in.; 20 cts.
American Gas Light Journal (Am. G. L. J.), New York, N. Y.; w; 10x13 in.; 10 cts.
American Institute of Electrical Engineers Proceedings (Am. I. of E. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
American Machinist (Am. Machst.), New York; w; 7x10 in.; 15 cts.
American Society of Civil Engineers Proceedings (Am. Soc. C. E. Proc.), New York, N. Y.; m; 4x7 in.; 75 cts.
American Society of Mechanical Engineers Proceedings (Am. Soc. M. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
Annales des Ponts et Chaussées (An. P. & C.), Paris, France; m. Architects and Builders Journal (Arch. & Bldrs. J.), Baltimore, Md.; m; 9x12 in.; 20 cts.
Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
International Railway Congress Bulletin (Int. Ry. Cong. Bul.), Brussels; m; 50 cts.
California Journal of Technology (Cal. J. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x19 in.; 20 cts.
Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
Canadian Mining Journal (Can. Min. J.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
Canadian Municipal Journal (Can. Mun. J.), Montreal, Que.; m; 6x10 in.; 10 cts.
Canadian Society of Civil Engineers Proceedings (Can. Soc. C. E. Proc.), Montreal; m; 4x7 in.; 50 cts.
Carpentry and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
Cement Age (Cem. Age), New York, N. Y.; m; 4x7 in.; 10 cts.
Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
Electric Railway Journal (Elec. Ry. J.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electric Traction Weekly (Elec. Trac. Wkly), Cleveland, O.; w; 7x10 in.; 10 cts.
Engineer (Engr. Lon.), London, England; w; 4x11 in.
Engineer (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Engineer (Eng.), London, England; w; 8x11 in.
Engineers' Club of Philadelphia Proceedings (Engr.' Club, Phila. Proc.), Philadelphia; qr; 4x7 in.; 25 cts.
Engineering-Contracting (Eng.-Contr.), Chicago; w; 7x10 in., 10 cts.
Engineering Digest (Eng. Dig.), New York; m; 5x8 in.; 20 cts.
Engineering and Mining Journal (Eng. & Min. J.), New York; w; 7x10 in.; 15 cts.

Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.
Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
Le Genie Civil Paris, France; w.
Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.
Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.
Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; \$1.
Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.
Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
Iron Trade Review (Iron T. Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.
Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
Journal of Electricity, Power and Gas (Jl. Elec. P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.
Mining and Scientific Press, (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Modern Machinery (Mod. Mch.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Municipal Journal and Engineer (Mun. J. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.
Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 in., 15 cts.
Power and Engineer (Pwr. & Engr.), New York; m; 7x10 in.; 20 cts.
Railway Age Gazette (R. R. Age. Gaz.), New York; w; 8x11 in.; 15 cts.
Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Roadmaster and Foreman (Rd. & For.), Chicago; 7x10 in.; 10 cts.
Rock Products (Rk. Prod.), Chicago, Ill.; bi-w; 9x11 in.; 10 cts.
Rose Technik, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr; 4x7 in.; 50 cts.
Schweizerische Bauzeitung, Zurich; w.
Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
Sibley Journal of Engineering (Sib. J. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.
Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.
U. S. Department of Agriculture Bulletin (Dept. Agr. Bul.), Washington, D. C.; 4x7 in.
U. S. Geological Survey Bulletin (Geo. Surv. Bul.), Washington, D. C.; 4x7 in.
Waterproofing and Fireproofing (W. P. & F. P.), New York, N. Y.; m; 5x8 in.; 10 cts.
Zeitschrift d. Oest. Ing. u. Arch. Ver. Vienna; w.
Zeitschrift d. Ver. Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Some Experiments Upon the Beam Like Strength of Brick Pavements. Engr.-Contr., July 8, 1908, 3 p.

Describes tests by Prof. Ira O. Baker of six beams of brick with grout joints, and draws comparisons with concrete beams of similar dimensions.

Road Construction Over Swamps and Peat Bogs. Engr.-Contr., July 29, 1908; 1-3 p.

Brief description of methods employed in the above work.

Automobiles and Road Wear. Mun. Jl. and Eng., July 22, 1908; 1½ pp.

An abstract of a paper read before the Incorporated Institution of Automobile Engineers of Great Britain. The paper treats of the causes of injuries to macadam by automobiles, and gives some data on the comparative bearing surface of different tires.

Data on Handling Cast Iron Pipe Culverts. Engr.-Contr., July 1, 1908; ½ p.

Gives cost data on the unloading, hauling and placing of cast iron pipe for culverts.

Data on Macadam and Gravel Road Work. Engr.-Contr., July 1, 1908; ½ p.

Cost per cubic yard of macadam for a road; also for gravel.

Killing Weeds Along Country Roads. Engr.-Contr., July 1, 1908; ½ p.

Gives some methods of killing the mustard, Canada thistle, horse nettle and other weeds.

The Cost of Applying Tarvia and Screenings to a Road. Engr.-Contr., July 1, 1908; ¾ p.

Describes methods in Camden County, N. J., by application of tarvia and screenings.

Methods of Using a Road Grader on Hills. Engr.-Contr., July 1, 1908; ½ p.

Describes methods of grading roads in hilly and stony places.

Method and Cost of Using Calcium Chloride as a Dust Preventative. Engr.-Contr., July 1, 1908; ¾ p.

Describes methods employed and results obtained by U. S. Official of Public Roads of a series of tests to determine value of calcium chloride as a dust preventative. Data on cost of work are included.

The Best Method of Mixing and Laying Tar-Macadam for Streets and Roads. By John S. Brodie, Surveyor, July 17, 1908; 1½ pp.

Describes the English method of constructing tar-macadam roads, describing the foundation, tar-macadam surface, method of mixing, laying, and gives limitations of tar-macadam roads.

SEWERS.

Sewage Purification at Washington, Pa. By R. W. Pratt, Eng. News, July 16, 1908, 51-3 pp.

An elaborate general description of the sewer system, old disposal plant and new disposal plant of 2,000,000 gallons daily capacity, with maps and plans of the filters and other structures. Tables of sewage analysis are given and the contract costs of the work are stated. A well written general descriptive article.

Contractor's Plant for the Sewage Purification Works at Washington, Pa. By R. F. Proctor, Eng. News, July 16, 1908, 1½ pp.

Describes lay-out and composition of contractor's plant for constructing sewage purification works, with some account of the methods followed in prosecuting the work.

Colloids in Sewage Purification. Mun. Jl. & Eng., July 1, 1908; 1 pp.

Brief summary of some experiments conducted at Hampton, England.

Sewerage and Drainage of New Orleans. Mun. Jl. & Eng., July 1, 1908, 3½ pp.

General illustrated articles describing sewerage and drainage system of New Orleans.

Sewerage Statistics. Mun. Jl. & Eng., July 22, 1908, 1½ pp.

Tables containing data collected by the

Sanitary section of the Boston Society of Civil Engineers. Reports on pumping and disposal of sewage are given from seven cities or towns.

Sewerage Statistics. Mun. Jl. & Eng., July 8, 1908; 3 pp.

Tables containing data collected by the Sanitary section of the Boston Society of Civil Engineers on the collection of sewage and the quantity discharged. Reports are given from 24 cities, and the article includes brief description of the methods employed in the cities reporting in cleaning sewers.

Standard Forms for Sewerage Data. By Harrison P. Eddy. Mun. Jl. & Eng., July 1, 1908; 1½ pp.

Shows the standard form recommended by the sanitary section of the Boston Society of Civil Engineers for use by cities and towns in reporting sewerage statistics.

Night Soil Collection and Disposal. Mun. Jl. & Eng., July 1, 1907; 3 pp.

Tables giving data collected by the American Society of Municipal Improvements. The tables contain reports from 43 cities on the methods of collection, apparatus used, amount removed, disposition, etc.

Hydrolytic Sewage Tanks. Mun. Jl. & Eng., July 1, 1908; 3 pp.

The article treats of the hydrolytic tank sewage treatment system at Norwich, England, and gives information as to the principles of action, the construction of the tanks, theory of operation, etc. The matter is taken from a paper by Arthur E. Collins, City Engineer of Norwich, England, read before the Incorporated Association of Municipal and County Engineers.

Plans for Sewerage Systems. Mun. Jl. & Eng., July 1, 1908; 1 pp.

Rules and regulations issued by New York State Board of Health for guidance of cities and towns in the preparation of such plans for sewer systems and sewage disposal works as may be submitted to the State Commissioner of Health.

Sewerage of Queens Borough. By Albert Schreiner. Mun. Jl. & Eng., July 1, 1908; 4½ pp.

Abstract of a paper used before the Municipal Engineers of New York City. The article is general in character.

Utilization of Residuals from Refuse Destructors. By H. Percy Boulnois, Surveyor, July 17, 1908; 2 pp.

Treats of the various methods of disposing of the residuals from refuse destructors, including various uses for clinkers.

The Hampton Doctrine in Relation to Sewage Purification. By W. Owen Travis, Surveyor, July 10, 1908; 3 pp.

A paper read at the Association of Managers of Sewage Disposal Works at Leicester, England. The Hampton doctrine teaches that the purification process is essentially a physical operation, being in its complete expression, a continuous dissolution action.

The Septic Tank Process. Surveyor, July 3 and July 10, 1908; 5 pp.

Full text of the Judgment by the U. S. Court of Appeals in favor of the Cameron Septic Tank Co. upholding the septic tank processes patent of the company; a summary of the history of the septic tank.

WATER-WORKS AND HYDRAULICS.

Planning the Execution of a Contract for a Dam, the Methods Used, Together with Some Notes and Comments on the Plant Needed and the Life of Such a Plant. Engr.-Contr., July 15, 1908; 4½ pp.

The dam was the Cross River Dam for the New York water supply. Gives plans of various contractors for doing the work, for plant lay-out, etc., with estimates of plant depreciations, plant required, etc. An article containing many data which will be found useful by engineers and contractors.

READY AUGUST 12

Road Preservation and Dust Prevention

By William Pierson Judson

M. Am. Soc. C. E.; M. Inst., C. E.

Author of "City Roads and Pavements"

Cloth; 6x9 inches; 144 pages; 16 illustrations

Price, \$1.50 net

THE preservation of surface and the prevention of dust on macadamized roads form the problem now to be solved by engineers charged with the maintenance of the many thousands of miles of broken-stone roads which have been built throughout the United States during the past decade.

During 1904, with the increased use of motor-cars, this problem became acute, and in 1908 it is conceded to be a matter of prompt betterment, or general destruction, of costly highways.

This implies that new roads proposed and in progress must be better built than the old ones; that they must be better bonded and surfaced; and that these results must be reached, if possible, without unduly increasing the cost.

Preservation of existing roads and dust prevention on them are the matters which are most urgent, and road-builders have been working and experimenting to these ends with results which are here for the first time compiled and condensed into book form.

CONTENTS

ROAD DUST—ITS CONTROL AND PREVENTION— Origin. Limestone dust. Motor-car effects. Need of Maintenance. Conditions, and methods of prevention.

MOISTURE—

Water as a dust preventive. Sea-water. Calcium chloride. Akonia. Lymanite. Fitts-Simmons patent dust layer. Conclusions.

OIL EMULSIONS—

Summary. Various oils used. Objections. Methods: Conk's emulsion; Westrumite. Westrumite 2. Pine oil. Coudroze. Apulvite. Sandisize. Crompold D. Dustoline. Terracolla. Pulvicide. Ermenite. Hahnite. Rapide. Mechanical emulsifier. Conclusions.

OILS—

Summary. Crude petroleum. Residual. Asphaltic. Slow distillation. Pipe line for California oil. Causes of failures. History: first use. Oil on stone roads. Oiled earth and sand roads. Substitutes for California asphaltic oils. Methods: petroleptic; rolling tamper. Cheap rural oiled roads. Oiled gravel roads. Oiled broken-stone roads. Repairs of oiled roads. Asphaltoline. Asphaltine.

COAL-TAR PREPARATIONS—

Summary. Refined tar: Heating-kettles; uniformity. Opinions. Methods: Success dependent upon four conditions. Failures and their reasons. History. Tar-spraying machines: competitive trials. Quality. Importance; characteristics: tests; uniformity. Tarvia "A." Clare's patent Tar-Compo. Methods: Cleaning and scraping; heating; spreading; covering; finishing; cost. Tarvia "B" or cold treatment: Sprinkling; cost. Tarvia on Massachusetts roads; in parks. Penetration. On Rhode Island roads. At Tiverton. Conclusions. Appliances: "White" machine.

TAR-SPRAYING MACHINES—

"Aiken's patent pneumatic tar-sprayer"; description; method; on new macadam; cost; use on old surface; details; cost. The "Tarspra"; description; method. Lassally-Johnston patent tar road-binder"; description; method; results in France and England. "Thwaites anti-road-dust machine"; description; method; cost. "Tarmacer"; description; method. Conclusions.

TAR-MACADAM—

Summary. Various forms. History. Hand mixing. Machine mixing. Method in England. Tarmace; objections; methods; extent of use; comparative costs. Tared crushed stone; kinds of rock; methods; surfacing old roads; poor method; comparative costs at seven places in England. The "Gladwell" system: summary; methods; cost; opinions. Tar-macadam in United States and Canada: summary; opinion; methods and costs. Comparative costs in Massachusetts; improved methods.

ROCK-ASPHALT MACADAM—

Summary. Sources of supply. Limitations of use. Methods; in Little Rock, Arkansas; details; cost. In Bowling Green, Kentucky; description of material; methods; results; cost. Use in "Gladwell" system. Sheet rock-asphalt; methods; cost. Binder for macadam.

BITUMITIC PAVEMENT—

Summary. Characteristics. Opinions. History; growth; extent; limitations; methods; semi-portable paving plants; description; views and key. Cost. (6 illustrations.)

INDEX.

Descriptive Catalogue on Request.

The Engineering News Book Dept.

220 Broadway, New York City

Cost of Sand for a Filter, Showing the Cost of Washing and the Per Cent Washed Away. Eng.-Contr., July 22, 1908; $\frac{1}{2}$ p.

Gives costs and other interesting data concerning sand washing at Lawrence, Mass., filter plant.

Coefficients of Discharge Through Circular Orifices. Eng. News, July 9, 1908; $\frac{1}{2}$ p.

Gives conclusions of elaborate series of tests made at Melbourne, Australia, by H. J. T. Bilton.

The Testing Station and Filter Plant and Improvement of the People's Water Co., by W. W. De Berard and Langdon Pearse, Oakland, Cal. Eng. Rec., July 25, 1908; 3 pp.

Describes the work done by the experts of this company in making tests to decide upon the best method of filtration to be inaugurated by this company. The testing apparatus is described, and forms shown upon which the results of the filtration investigations are kept. A large number of experiments were made. An interesting article for water works engineers and superintendents.

Hydraulic Power Development by the Town of Kenora. Eng. Rec., July 18, 1908. 2 pp.

A description of the general design of this plant and of the construction, illustrated with drawings and photographs.

Recent Developments in Fire Protection. By Gorman Tana. Tech. Qr., June, 1908. 22 pp.

Reviews the importance of fire protection. Gives historical data as to appliances for extinguishing fires. Then automatic sprinklers are described and in connection with them various dry valves. Next is taken up alarm valves, then gravity and pressure tanks, followed by a discussion of various kinds of pumps. Then alarm services are described and protection of buildings by fire doors, shutters, wired glass, hose and hydrants.

Steel Sheet Piling for Pipe Line Trench. R. R. Age Gaz., July 3, 1908; 1 p.

Gives the method of driving the steel piles and of making them water tight in quicksand. States the lump sum cost of material and driving, and compares this with the possible costs, if lumber had been used. Shows a saving of 48 per cent.

Repairs to a 72-in. Main Under 20 ft. of Water. By A. W. Cuddeback. Con. Engr., July 3, 1908. 3 pp.

Describes construction of concrete encased steel water main under Hackensack River for the water supply of Jersey City and in detail the methods adopted on two occasions to repair leaks which had developed under water.

Water Hammer Tests. Eng.-Contr., July 1, 1908; $\frac{3}{4}$ p.

Gives results of tests made to measure the water hammer effect caused when a hydrant is quickly shut down.

Reducing the Cost of Coal in the Boiler Room of Water Works. By W. L. Watson. Eng.-Contr., July 1, 1908; 1 p.

Gives methods adopted to reduce fuel costs of pumping and results of comparative economy tests of new method and method previously used. The article is of decided interest to power plant engineers.

Corrosion of Steel and Iron Mains. Mun. Jl. & Eng., July 29, 1908; $1\frac{1}{2}$ pp.

Gives experiences with water mains in Rochester, Atlantic City, Allegheny, Pittsburgh, Cambridge, New Bedford and Portland, Ore., and probable causes of corrosion.

The Water Softening and Filtration Plant at McKeesport, Pa. Eng. Rec., Aug. 1, 1908; 4 pp.

Gives an account of the new water softening system and filtration plant built by this town, describing the methods of treating the water and of constructing the plant.

Wells and Boreholes for Town Water Supply. By H. Ashton Hill. Surveyor, July 17, 1908; 6 pp.

In this paper, which was read before the Association of Water Engineers at Birmingham, England, the author discusses in a general way from his personal experiences, the matter of sinking wells and boreholes. The subjects treated in the paper include: Legal right to take underground water; analytical conditions of underground water; relative merits of wells and boreholes and notes on construction.

The Design and Construction of Impounding Reservoirs. By Wm. Watts, Surveyor, July 3, 1908, 3 pp.

A paper read at the annual meeting of the Association of Water Engineers at Birmingham, England. In it the author epitomises some of his experience extending over a period of 40 years, including the construction of 18 reservoirs for the water supplies of large cities, and of a number of smaller ones for private firms.

DRAINAGE AND IRRIGATION.

An Analysis of Cost on a Simple Drainage Contract. Contr., July 15, 1908; 1 p.

Describes ditch construction with dredges in Kishwaukee Drainage District, Illinois, and gives itemized cost of dredge work.

RIVERS, HARBORS AND CANALS.

Lock Gates at the Charles River Dam, Boston and Cambridge, Mass. By E. C. Sherman. Eng. News, July 9, 1908; 4 pp.

General description, with drawings of important details, of steel gates for lock through Charles River Dam.

Break in the Cornwall, Ont., Canal and the Consequent Draw Bridge Collapse. Eng. News, July 9, 1908; $3\frac{1}{2}$ pp.

Describes break in canal, and undermining of draw bridge pier by flood. The method of repairing the break is briefly described and is of somewhat special interest.

An Extensive Sea Wall at Coronado Beach, California. Eng. Rec., July 18, 1908; 2 pp.

A description of the method of building a heavy rip-rap shore protection along the Pacific Ocean front of this beach. Plans showing cross-section of protection are given and the work in detail is described.

Pneumatic Caisson Foundation for the Light House at the Elbow of Cross Ledge, Delaware Bay. Eng. Rec., July 25, 1908; $1\frac{1}{2}$ pp.

Describes the situation of this light house and the design of the metal caisson and the method of towing it into position and sinking it in place. Considerable trouble was experienced in towing.

U. S. Improvements of the Columbia River, Oregon and Washington. By W. P. Hardesty. Eng. News, July 30, 1908, 8 pp.

General description with illustrations of the jetty work at the mouth of the Columbia River and also of the Celilo-Dalles canal around the rapids in the same stream. The general methods of construction adopted are explained, and contract prices are given. A good general descriptive article.

RAILWAYS.

Cost of Driving an Earth Tunnel for a Railroad. Eng.-Contr., July 1, 1908; 2 pp.

Gives detailed costs of constructing a single track, soft ground, timber lined railway tunnel 2,360 ft. long, with a description of methods of work. A valuable cost article on soft ground tunneling.

Cost of Transporting Men, Tools and Supplies on Railroads for Grading. Eng.-Contr., July 8, 1908; $\frac{3}{4}$ p.

Gives figures for use in estimating cost charges to be made on railway work for expense of transporting men, tools and supplies.

IN PRESS—Ready about Sept. 1, 1908

The Design of Highway Bridges

and the

Calculation of Stresses in Bridge Trusses

By MILO S. KETCHUM,
C. E., M. Am. Soc. C. E.

Dean of College of Engineering, and Professor of Civil Engineering, University of Colorado. Author of "Steel Mill Buildings" and "Walls, Bins and Grain Elevators."

Cloth; 6x9 inches; xiv + 550 pages; 300 figures in the text, 77 tables, and 48 folding plates. Printed and bound uniformly with "Steel Mill Buildings" and "Walls and Bins."

Price, \$4.00 net

TABLE OF CONTENTS

Part I.

Stresses in Truss Bridges.

Chapter	I. Types of Truss Bridges.
"	II. Loads and Weights of Bridges.
"	III. Methods for the Calculation of Stresses in Framed Structures.
"	IV. Stresses in Beams.
"	V. Stresses in Highway Bridge Trusses.
"	VI. Stresses in Railway Bridge Trusses.
"	VII. Stresses in Portal and Lateral Systems.
"	VIII. Stresses in Pins, Combined and Eccentric Stresses, Stresses in Rollers, Deflection of Trusses, Camber, etc.
"	IX. The Solutions of 24 Problems in the Calculation of Stresses in Bridge Trusses.

Part II.

The Design of Highway Bridges.

Chapter	X. The Design of Short Span Steel Bridges.
"	XI. The Design of High Truss Steel Bridges.
"	XII. The Design of Plate Girder Bridges.
"	XIII. The Design of Truss Members.
"	XIV. The Details of Highway Bridge Members.
"	XV. The Design of Abutments and Piers.
"	XVI. Stresses in Masonry Arches.
"	XVII. Design of Masonry Bridges and Culverts.
"	XVIII. The Design of Timber and Combination Bridges.
"	XIX. The Erection and Cost of Highway Bridges.
"	XX. Principles of Design of Highway Bridges.

Part III.

Highway Bridge Details.

Chapter	XXI. Estimate of the Weight of a 160 Foot Span Steel Pin-Connected Highway Bridge.
"	XXII. Calculation of the Efficiencies of the Members of a 160 Foot Span Steel Pin-Connected Highway Bridge.
Appendix	1. General Specifications for Steel Highway Bridges.

WRITE FOR FURTHER INFORMATION

The
Engineering News Book
Department

220 Broadway

New York

Price of Rails for Thirty-two Years. Eng.-Contr., July 8, 1908; 1 p.

Table showing price of rails for every year from 1876 to 1907, inclusive.

Cost of Reconstructing Street Railway Cable Line into Electric Line at San Francisco, Cal. Eng.-Contr., July 29, 1908; 2 p.

Summarizes by items cost of taking out old cable construction and building new track for electric power. Special methods of work kept the cost down to slightly over \$5 per lineal foot of track.

Mashed and Split Rail Heads on the Burlington System. Eng. Rec., July 18, 1908. 2 p.

Abstracted from a paper by W. H. Wickhorst, Engineer of Tests of the Burlington, delivered before the American Society for Testing Materials. Shows some rails with mashed heads, and gives an explanation for such splitting of the rails. Also gives the chemical analysis of samples taken from these rails.

Telephoning in Railroad Operation. By W. E. Harkness. R. R. Age Gaz., July 3, 1908; 2½ pp.

A paper read before the New York Telephone Society. Shows the use of telephones in conducting railroad business, and especially in train dispatching. Reviews the use of the telephone for this work in the past, and shows that many roads are investigating its merits, or are making tests of the telephone for train dispatching.

Some Features of the Present Steel Rail Situation. By C. B. Dudley. Eng. News, July 2, 1908; 2¼ pp.

This is an unusually interesting presentation of the modern service conditions affecting rail design and of the work which has been done so far to meet these conditions. An article of interest to railway engineers.

T-Rail Track Construction in Detroit. Elec. Ry. J., July 25, 1908; ½ p.

Illustrates track structure and describes briefly method of construction using car-mounted concrete mixer and crew car for concrete work.

Spiral Table of the Canadian Pacific Railway. Eng. Rec., Aug. 1, 1908; 6 pp.

Gives tables prepared for use on this railroad, based on Holbrook's Spiral. Gives the formula and the principles on which the tables are based, and a mathematical discussion of this spiral. Also shows how to use the tables. Illustrated with a number of drawings.

BRIDGES, BUILDINGS AND FOUNDATIONS.

A Model Car Repair Shop. Elec. Ry. J., July 4, 1908, 6 pp.

Reprint of report of committee of the Street Railway Association on a model car repair shop for a road operating 100 cars. The requirements are stated and complete plans and description of shop meeting these requirements are given. A detailed estimate of the cost of the shop described is given.

New Buildings for the United States Naval Academy, Annapolis, Md. By Ernest Flagg. Am. Arch., July 1 and 8, 1908; 34 pp.

Describes from architectural viewpoint the elaborate new Naval Academy buildings for the U. S. Government at Annapolis, Md. The article is accompanied by numerous plans and handsome half-tone views of the completed buildings.

Method of Erecting Transmission Line Towers in Assembled Condition by Means of Gin Poles, with Some Data on Cost. Eng.-Contr., July 1, 1908; ½ p.

The towers were of structural steel averaging 2,200 lbs. in weight. The article describes method of assembling tower and its erection complete, with gang organization and general costs of erection.

Method of Removing the Large Train Shed at Grand Central Station, New York. By G.

"I would have given \$1,000.00 for this book a year ago."—W. H. BURK, Knoxville, Tenn.

"FIELD SYSTEM"

By FRANK B. GILBRETH, M. Am. Soc. M. E.

WHO THE AUTHOR IS.—Frank B. Gilbreth is the contractor who has made the "cost-plus-a-fixed-sum-contract" famous. In order to handle contract work scattered all over North America, Mr. Gilbreth found it necessary to develop a system whereby his foremen would execute work properly, promptly and economically. The code of rules and instructions to his foremen, and the printed forms for their reports, were bound in book form, and this book Mr. Gilbreth called his "Field System." Mr. Gilbreth's contracts have covered the widest possible range. Railways, canals, dams, factories, office buildings, whole industrial towns, are among the works that he has executed.

WHY ENGINEERS SHOULD STUDY "FIELD SYSTEM."—Every engineer should know how to manage men, for, whether he confines himself to purely professional work or enters into business of executing construction work, his ambition should be to direct the men under him in a manner that will secure the greatest possible efficiency. A revolution in the art of managing men is now in progress. Direct personal supervision was once deemed essential. To-day, however, "system" is fast supplanting personal supervision. By "system" we mean printed or written directions for employees to follow, and daily reports that show what the employees have done. System of this sort has recently been extended to the field survey work of the U. S. Geological Survey. While Gilbreth's "Field System" is not a system for the management of surveys, for example, it is rich in suggestions that can be applied in the management of any kind of field work, whether employees are engaged in surveying or in construction. Its rules and methods are applicable to office work, in so far as the principles involved are concerned. The book, in brief, is a treatise on the science of managing men by system. No engineer who aims to be more than a subordinate can afford not to have this treatise, written by a man who is an acknowledged adept in managing men.

Hundreds of engineers have gone into the contracting business during the past few years, and there is room for thousands more. But if they are to succeed in any great measure, it must be by the intelligent application of system and cost analysis. Gilbreth's "Field System" does not cover the whole field, nor was it written to cover it, but it does cover a very important part of the field, and a part upon which practically nothing has ever been written.

WHY CONTRACTORS SHOULD HAVE "FIELD SYSTEM."—Mr. Gilbreth has done in contracting what Mr. W. L. Douglas and Mr. Marshall Field have done in the mercantile field. He has taken a class of work involving endless detail, and has reduced the handling of these details to a system by virtue of which economy in construction and celerity in performance are secured, regardless of place or men. Every one has heard the expression, "one-shovel contractor," meaning a contractor capable of managing only one steam shovel at a time. The "one-shovel contractor" is the antithesis of the contractor having a system. The "one-shovel contractor" receives daily reports, it is true, but his reporters are his two eyes. The "one-shovel contractor" has a code of instructions for his men, it is true, but his ready tongue is the only leaf of a code bound between the cover of two jaws. The day of the "one-shovel contractor"

is not yet gone entirely, but it will pass rapidly away. Every contractor should have a field system of his own, embodying his own experiences and covering his own necessities, but in the developing of such a field system no contractor can afford not to study the work of Mr. Gilbreth.

COPIES OF "FIELD SYSTEM" STOLEN.—When it became generally known that Mr. Gilbreth had supplied his foreman and superintendents with printed instructions, copies of the book were bribed from his employees, and photographed page by page, from cover to cover. Other copies were "lost," and thus made way with entirely. Huge salaries were used to hire away Mr. Gilbreth's superintendents, for the purpose of getting not only their trained services, but for their knowledge of the contents of the "Field System."

MAKING THE BOOK PUBLIC.—Mr. Gilbreth's action in making public his "Field System" in its entirety is without precedent in the world of business. It is an act that puts contracting on the high professional level of civil engineering. The civil engineer discloses his method of designing a structure, his purpose being to assist other engineers in doing as well. In the interest of scientific advancement the engineer places on record what he has found to be economic or effective. In the same spirit—we may call it the modern American spirit—Mr. Gilbreth has permitted publication of his private code of instructions to his men—his "Field System." He believes that contractors, and, indeed, all professional business men, will become far more efficient as managers of men if such systems as this are disclosed. He believes that in the general rise of efficiency that will occur all those engaged in business will share. He believes that those who are best fitted to be leaders will remain leaders. Character, experience and ability will have the same relative weight as ever. In these beliefs every broad-minded man ought to concur.

China is a nation that worships "trade secrets." It is a nation of industrial mutes. Their arts and their manufactures are taught by father to son, and zealously guarded. There has been no pyramiding of improvements upon one original invention as a base. The Chinese do not lack inventive ability. They are merely cursed by the curse of secretiveness. Their industries are plastered with signs of "No admittance," and are mummified in consequence. In striking contrast with the Chinese method is the American method. Our doctors, or engineers and our men of science generally have never concealed their discoveries or their improvements. Latterly our business men have shown a recognition of the truth of the general proposition that it pays the individual to share his discoveries with the rest of his fellows. Such generosity, in the final analysis, is simply an enlightened selfishness. The publishers of Gilbreth's "Field System" urgently request other contractors and business men to come forward with their systems, and put them permanently on record. Let business men generally adopt the altruistic policy that actuates professional men, and in its prosperity America will soon rise as far above its present level as it now stands above the level of the Chinese Empire.

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A. Harwood. Eng.-Contr., July 1, 1908; 1½ pp.

Illustrates in detail the large traveling center used in removing the 200-ft. span roof arches and describes general method of work.

Raising the Broadway Bridge, Boston. Eng. Rec., July 18, 1908; 1 p.

This bridge was a swing draw bridge, 165-ft. span, 60 ft. wide. It was necessary to raise it to conform to some improvements being made, and the article is given over to a description of the method of accomplishing this work. The article is illustrated. The work was done quickly and economically.

Highway Bridge Across the Kansas River at Fort Riley, Kansas. By Capt. P. S. Bond. Eng. Rec., July 11 and 18, 1908; 6 pp.

This is a timber bridge, through Pratt truss, built by the corps of engineers, U. S. A. It is supported on cylindrical steel piers. The author describes in great detail the design and construction of the bridge, and the methods used in erecting. The work was done by the engineering corps, with enlisted men, and the time consumed in doing the various kinds of work is given. A very interesting article.

CONCRETE AND REINFORCED CONCRETE.

Examples of Labor-Saving Machinery and Methods of Placing Concrete Tunnel Lining. Eng.-Contr., July 1, 1908; 4 pp.

Describes and illustrates traveling centers and side wall forms, derricks, conveyors for back filling, etc., used in constructing concrete lining for tunnels. Methods of operating the various machines are explained and general costs and capacities are stated.

Cost of a Reinforced Concrete Railroad Culvert in Montana. By Henry A. Young. Eng.-Contr., July 1, 1908; 1 p.

Describes method of construction and gives complete cost in detail of constructing an arch culvert for an irrigation canal running under railway embankment. The costs are fully itemized and classified.

Recent Experiences with Reinforced Concrete and Concrete Block Buildings in Fires. Eng.-Contr., July 8, 1908; 1½ pp.

A record of recent fires in concrete buildings compiled by a committee of the National Fire Protective Association. Character of building and fire is stated, the destruction noted and conclusions drawn.

Methods and Some Costs of Constructing a Reinforced Concrete Arch Bridge. By John Harms. Eng.-Contr., July 22, 1908; 2½ pp.

Describes method of constructing three-arch concrete railway bridge, with drawings of forms and costs of portions of the work.

Test of Reinforced Concrete Beams 25 ft. Long, 6¼ ft. wide and 2 ft. 10 ins. Thick. Eng.-Contr., July 29, 1908; 4 pp.

Describes bending test made on flat beams or slabs of dimensions noted, with results in diagram and tabular form.

Reinforced Concrete Hollow Floors Constructed Without Cementing. By Frederic R. Farrow. Conc. & Cons. Eng., July, 1908; 5 pp.

Describes and illustrates a number of types of floor construction of separately molded hollow members.

A Summary of the Rules, Regulations and Recommendations for the Use of Reinforced Concrete as Published in Various Countries. By Charles F. Marsh. Conc. & Cons. Eng., July, 1908; 11 pp.

Gives in parallel columns essential clauses of rules, regulations, etc., for reinforced concrete construction in force in Great Britain, Germany, France, Switzerland, Austria and the United States (New York City). The main facts brought out by the comparison are briefly discussed.

Cost of Concrete Manhole Construction. By Clarence Mayer. Contr., July 15, 1908; 3½ pp.

Describes standard concrete vault construction for underground telephone conduit; illustrates wood and steel forms used, and gives average costs itemized for materials and labor. An unusually good cost article.

Methods of Constructing a Large Reinforced Concrete Sewer, Using Steel Centers, at St. Louis, Mo. Eng.-Contr., July 1, 1908; 11-6 pp.

Describes general method of constructing 29x19-ft. sewer, using collapsible steel centers.

Tests to Determine the Effect of Addition of Hydrated Lime on the Water-Tightness of Concrete. Eng.-Contr., July 15, 1908; 1½ pp.

Describes methods of conducting tests and gives results and conclusions drawn from them. The tests were made by Mr. Sanford E. Thompson, and show the effective proportions of hydrated lime for water-tight concrete to be as follows:

Pts. Pt Cm.	Pt. Sand.	Pt. Stone.	P. C. Lime.
1	2	4	8
1	3	5	16
1	2½	4½	12

These percentages are based on the weight of the dry hydrated lime to the weight of the dry Portland cement.

Reinforced Concrete Conduits for Electric Cables, Long Island R. R. By F. Auryan-sen. Eng. News, July 23, 1908; 1 p.

Gives drawings and general description of conduit construction consisting of 18-duct vitrified conduit encased in concrete reinforced to act as a beam and supported on concrete piles.

Bridges and Culverts for Highway Traffic. Expanded Metal and Corrugated Bar Co., St. Louis, Mo. July, 1908; 30 pp.

This is the third pamphlet issued by this company on the theory and design of reinforced concrete structures. In this, special problems met with in the design of highway bridges and culverts are discussed and detail designs of flat slab bridges, box culverts and girder bridges are given. These are useful bulletins for engineers. They can be had by those interested in concrete construction for the asking.

Some Tests of Concrete Beams Under Off Repeated Loading. Eng. Rec., July 25, 1908; 3½ pp.

A paper presented to the American Society for Testing Materials by H. C. Berry. Tells of a set of tests made at the Laboratory of the University of Pennsylvania. The effect of a great number of repetition of working loads on the strength, and elastic properties of concrete beams was studied. Illustrated with drawings and diagrams.

The St. George Ferry Approach Improvements, New York City. Eng. Rec., July 11, 1908; 3 pp.

Describes the design of a retaining wall of reinforced concrete that is being built in connection with this ferry improvement, and gives in detail a description of the methods of building the wall, there being several novel features in the construction.

Metal and Wooden Forms in Concrete Construction. By L. C. Wason. R. R. Age Gaz., July 3, 1908; ½ p.

Discusses some economic features of forms for concrete. Points out objections to metal forms, and when it is profitable to use them. Speaks of the incompetent class of carpenters that has to be employed for timber form work. Shows by an example that to decrease the amount of concrete may so increase the cost of forms as to add to the total cost of the structure. Discusses the use of rough and planed timber, and the thickness of boards to use in making forms. A short article with a number of valuable suggestions.

The Use of Concrete Piling in the Board Walk at Atlantic City. By Aldrich Durant. R. R. Age Gaz., June 17, 1908 (daily issue). 3½ pp.

Describes in detail the making and driving

Cements, Mortars and Concretes

—Their Physical Properties

An up-to-date Compendium of Reliable Tests of Cements, Mortars and Concretes

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MYRON S. FALK, Ph. D.

Instructor in Civil Engineering, Columbia University.

This book contains a very complete report of the results of tests made during the past fifteen years, and gives these results in tables and diagrams classified according to subjects. This is a reference book that should be in the library of every civil engineer. The contents include chapters on Chemical Properties of Cement, Physical Tests of Cement, General Physical Properties, Elastic Properties in General, Tensile Properties, Compressive Properties, Flexural Properties, Report on Uniform Tests of Cement by the Special Committee of the American Society of Civil Engineers, and Constitution of Cement.

Cloth, 6x9 inches; 184 pages; illustrated; price \$2.50 net, postpaid.

Practical Cement Testing

By

W. PURVES TAYLOR, M. S. C. E.

Engineer in Charge of Philadelphia Municipal Testing Laboratories.

This is the first practical and exhaustive treatise on this important subject. It has already been adopted as a text-book by the University of Pennsylvania and other technical schools. Each chapter contains a minute description of the methods followed in the author's laboratory and many valuable suggestions as to the "how" and "why" of cement testing. The observations on the interpretation of results, one of the most difficult tasks of the novice, are especially pertinent and are expressed in a fair and conservative manner.

The book is so complete that it can be out in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of texts are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, Am. Soc. C. E.; Am. Soc. Test. Mtls.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6x9 inches; 330 pages; 142 illustrations; 58 tables; \$3.00 net, postpaid.

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of the piles used in replacing the steel supports of the board walk at Atlantic City. The piles were cast and then driven by a water jet, and afterwards settled, so that they would not sink under their load. Many details of the work are described and plans and photographs further illustrate them.

The Strength of Concrete Beams. By Richard L. Humphrey. Geo. Sur. Bul. No. 344; 58 pp.

The first bulletin of a series, giving the results of tests of 108 beams, made at the structural-materials testing laboratories of the government. The investigations made involved a study of the constituent materials of concrete, of its strength when molded into various structural shapes, and of the methods by which its maximum strength may be developed through various forms of metal reinforcement. The results obtained are given in tabular form, and are commented upon and illustrated by diagrams. Should be procured by every one interested in concrete.

Thin Walls for a Car Shop. Eng. Rec., July 4, 1908; ½ p.

Describes a car shop built by the N. Y. C. & H. R. R. at Mott Haven, having the outside walls made of cement mortar, reinforced with truss metal lath, the thickness of the walls being 2½ inches.

A Discussion of Metal and Wood Forms for Concrete Construction. Eng.-Contr., July 8, 1908; ¾ p.

Compares advantages of metal and wood forms and gives general suggestions for wood form work.

Cost of Two Small Concrete Structures for an Irrigation Canal. Eng.-Contr., July 8, 1908; ½ p.

Gives itemized cost of concrete waste-way and concrete drop with two-way turn-out, with general description of structures.

Reinforced Concrete in Engineering Structures. By C. S. Meik, Surveyor, July 10, 1908; 11 pp.

A paper read before the Institution of Municipal and County Engineers at Nottingham, England. In it the author describes generally some of the systems of reinforced concrete construction carried on in works under his supervision. Among the works described are the construction of King's dock at Swansea, Purfleet Pier, figures of cost, and detailed drawings for these works being given. Various tests of reinforced concrete beams are included in the article as is much information on reinforced concrete piles.

EARTH AND ROCK EXCAVATION.

—**The Santo Amaro Reservoir and Hydraulic Fill Dam, Brazil.** By Thomas Berry. Eng. Rec., July 4, 1908; 3 pp.

A general description of the location and size of the reservoir is given by the author; then he describes in some detail the method of building that part of the reservoir that was sluiced. The features of interest were the delivery of about 121,000 cu. yds. of sand and clay by means of a "booster" centrifugal pump through 1,200 ft. of pressure pipe, and the elevation of about 39,000 cu. yds. of sand and clay by a hydraulic elevator through a vertical height of 26 ft. These methods of elevating sluiced materials have been used in hydraulic mining, but their application to reservoir construction is new.

Experiments in the Permeability of Earths. By G. Thiém. W. P. & F. P., July, 1908; 1½ pp.

Translated from La Technique Sanitaire by Miss A. A. Garrigan. Experiments made with earths to determine their permeability and to establish the use of the Darcy-Dupuit formula, which is based on the proportionate speed of water circulating through a porous medium and the loss of pressure that produced the movement. In the experiments, fine, medium and heavy sands were used and small gravel.

Now Ready CONCRETE CONSTRUCTION METHODS AND COST

By

Halbert P. Gillette

M. Am. Soc. C. E., M. Inst. M. E.,
Managing Editor, Engineering-Contracting
and

Charles S. Hill, C. E.,

Associate Editor, Engineering-Contracting.

THIS book handles the subject of concrete construction entirely from the view-point of the *builder* of concrete structures. The testing of cement, the physical properties of cements and concrete, and the design of concrete structures are not considered. The aim of the authors has been to eliminate all matter not germane to the constructing end of their subject. By doing this it has been possible to crowd a vast amount of detailed information on methods and cost of concrete construction into a volume of moderate size. The book is a treatise on the *methods and cost* of building in *concrete*.

WHILE concrete design is not considered, no designer of concrete can be a really good designer without having a profound knowledge of costs and of practical methods of construction. This book will be of interest therefore to every engineer and architect who is engaged in designing concrete structures. It should be of particular assistance, however, to the contractor or engineer engaged in the actual work of making and placing concrete.

THE methods given are practical methods and they are so given that the practical man can use them. The costs given are actual costs, itemized, analyzed and reduced to units. Costs of material, costs of transporting, costs of mixing, costs of placing, costs of tamping, costs of finishing, costs of forms, costs of bending and placing reinforcement, costs of waterproofing, costs of superintendence, costs of plant, interest charges, depreciation charges are all given, and to make these costs useful, the conditions and the methods of doing the work are stated in each case.

Cloth, 6 x 9 inches, 700 pages, 306 illustrations, \$5 net, postpaid.

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355 Dearborn St., Chicago, Ill.

Cost of Excavating Sand in Trench with an Orange-Peel Bucket. Engr.-Contr., July 15, 1908; $\frac{1}{2}$ p.

Gives the method of operating bucket and crew used on the work, with a cross-section view of the trench. States the total cost of the work and the number of cubic yards moved, thus showing the unit cost, which was 5.3 cts.

Some Cost Data on Irrigation Canal Excavation with Fresno Scrapers. Engr.-Contr., July 15, 1908; $\frac{1}{2}$ p.

Gives the cost on 10 different jobs of excavation on the Belle Fourche Project. Shows the number of cubic yards moved on each job, the overhaul and the cubic yards moved per man-day and also per horse-day.

An Air Jet Used to Load Wagons From a Hopper. Engr.-Contr., July 15, 1908; $\frac{1}{2}$ p.

Shows by description and a line drawing how an air jet was used to dump dirt from a hopper into wagons, the material being stiff wet clay and quicksand. The cost of the work was materially reduced by this trick.

Miscellaneous Cost Data on Irrigation Canal Work for the U. S. Reclamation Service. Engr.-Contr., July 15, 1908; $\frac{1}{2}$ p.

Gives the cost of several items of excavation, earth embankment, rock fill, back filling and some concrete work on the Lower Yellowstone Project. Shows both the cost to the contractor and to the government.

Construction of New Boston Levee. Eng. Rec., July 18, 1908; $\frac{2}{3}$ p.

Describes the method of building a levee on the Mississippi River at New Boston, Ill., with a Lidgerwood excavator. This consists of a traveling derrick car with a 50-ft. boom, swinging in complete circle and operating a scraper basket. The method of operating is described and the crew used and the amount of work done daily are given.

The Second Section of the Harlem Creek Sewer in St. Louis, Missouri. Eng. Rec., July 11, 1908; $\frac{2}{3}$ p.

Describes the methods used in excavating the trench for this sewer. The trench being 33 ft. wide and from 25 to 51 ft. deep, the lower 8 ft. being in solid limestone. Cableways, steam shovels and small cars are being used.

Some Records of Channeling, Drilling and Cableway Work. Engr.-Contr., July 8, 1908; $\frac{1}{2}$ p.

Records for these classes of work, done on the West Neebish channel of the improvement of St. Mary's River between Lake Superior and Lake Huron, are given. The work was done in Niagara limestone, and 1,700,000 cu. yds. were excavated. This job was said to have been done under good management, hence these records are of value.

A Contest of Different Makes of Pneumatic Hammer Drills. By J. Orr. Engr.-Contr., July 1, 1908; 7 pp.

Condensed from a paper from the Journal of the Transvaal Inst. of Mechanical Engineers. Describes the results of a contest for stope drilling, for a trophy costing \$500. The condition of the contests are set forth and the results obtained from each contesting drill are listed. Some of the results obtained by the winning drill, "The Gordon," are given in a table, while another table shows the general summary of work done by each drill in the surface trials. Each drill was worked underground and on the surface.

Nine Examples of the Cost of Wheel Scraper Work, with Comments on Handling Scraper Gangs. Engr.-Contr., July 8, 1908; $1\frac{1}{2}$ pp.

Gives the cost in great detail of nine examples of working scrapers on railroad construction and comments are made to show wherein the work was handled wrong, and suggestions are offered to improve the handling of the scrapers. This article is of especial interest to contractors.

Cost of Excavating and Lining a Small Tunnel, with Shafts, Under a River. By Clarence Mayer. Engr.-Contr., July 8, 1908; $\frac{1}{2}$ p.

The tunnel was built to carry electrical cables under a river. The length of the tunnel was 434 ft., being 6 ft. wide, the lower half being $3\frac{1}{2}$ ft. high, with an arch of 3-ft. radius at the top. The deepest shaft was 84 ft. The costs are given in detail.

Tests of the Water Level in the South Dike of the Wachusett Reservoir. Eng. Rec., July 18, 1908; $\frac{1}{2}$ p.

Describes the tests made on this dike during the past few months to show if the embankment was impermeable. The results are gratifying, showing that beyond the core of soil, water from the reservoir does not enter the dike, it being practically impermeable.

Cost of Excavating Earth with an Electrically Equipped Shovel. Engr.-Contr., July 22, 1908; 1 p.

Gives the method of operating this shovel in a gravel pit, and tells of the electrical equipment placed on the shovel. Likewise gives records of work done by the shovel, with the cost of the various details. A useful article for those interested in the work of small shovels.

Examples of High and Low Cost of Wheel Scraper Work, with Comments on the Efficiency of Work Done. Engr.-Contr., July 22, 1908; 1 p.

Describes two jobs, the cost of one being high and the other low. Points out reasons for this difference in cost and comments on foremen and foremanship, giving suggestions as to training young men to be capable foremen.

The Cost of Repairs to Locomotives and Cars. Engr.-Contr., July 22, 1908; $\frac{1}{2}$ p.

Gives the cost of repairing locomotives as used on the Panama canal for a period of 11 months, showing the proportional cost of the repairs to the original cost of the locomotives. Also gives the cost of repairs to some steel dump cars of 80,000 lbs. capacity, used by a contractor in handling earth and rock.

The Cost of Digging Wet Holes, With Some Comments on Furnishing Special Clothing for Workmen. Engr.-Contr., July 29, 1908; 1 p.

Gives the method of digging the holes and the total cost, reduced to cost per hole for various details, and also to the cost per cu. yd. Comments are made on protecting men from inclement weather while at work, by clothing furnished by the contractor.

MATERIALS OF CONSTRUCTION.

Structural Timber. By W. K. Hatt, Wn. Ry. Club, March, 1908; 28 pp.

An address on structural timber, confined to a discussion of the physical character of wood and indicating the effect on its strength of various elements arising during the growth of the tree, and of some of the various operations which are necessary in preparing the material for the market. The rate of growth is considered, also the color, knots, shapes and checks, effect of moisture, and the steam and preserving. Various tests for strength made under the author's direction are also described, with the results obtained given. A useful paper.

MISCELLANEOUS.

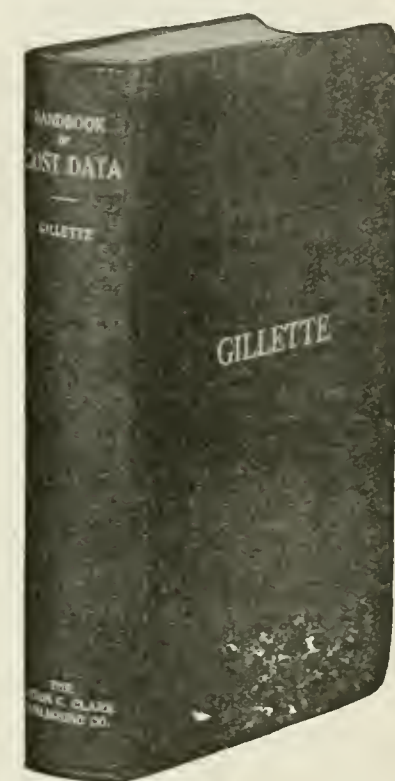
Two Years of the Co-operative Engineering Courses at the University of Cincinnati. Eng. Rec., July 25, 1908; $2\frac{1}{2}$ pp.

Describes this system of education which has been practiced by this university for two years with success. It consists of working the student in some commercial machine shop for a week and then attending to his studies for a week, thus alternating work with his college course. The results and merits of this system are pointed out and comments made upon applying this method

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M. Am. Soc. C. E. Editor "Engineering-Contracting"

"Cost Data" has broken all records for the sale of technical books. Over 10,000 copies were sold in less than two years; 1,600 in last three months. The book has over 600 pages of actual costs taken from the private records of engineers and contractors, and so itemized and analyzed as to be of inestimable value to any person who has to do with making bids and estimates or in checking estimates. This covers the whole field of contract work, giving the cost of labor and materials required for every kind of construction from the laying of sod to the building of reinforced



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Cost of Concrete Construction, all kinds.
Cost of Water-Works.
Cost of Sewers, Vitrified Conduits and Tile Drains.
Cost of Piling, Resting, Timberwork.
Cost of Erecting Buildings.
Cost of Steam and Electric Railways.
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of instruction to other engineering courses, such as the civil and the marine field.

Methods and Cost of Constructing Telephone Booths, Buffalo, Lockport & Rochester Ry. Eng.-Contr., July 8, 1908; 1/2 p.

Gives plans of booth construction and cost of construction.

Some German Costs of Manufacturing Brick. Eng.-Contr., July 15, 1908; 1/2 p.

Gives itemized cost of brick manufactured in two German brick yards.

Method of Realigning Steam Pipe for Power Plant, with Examples of Steam Pipe Hangers. Eng.-Contr., July 29, 1908; 2 pp.

Describes method of realigning a steam pipe in the dark and illustrates and describes some dozen or so forms of pipe hangers, with comments on their advantages and defects.

Variation in Weight of Stone. By H. F. Alexander. Eng.-Contr., July 29, 1908; 1/2 p.

Gives results of tests to determine loss in weight of quarry stone due to seasoning.

Wholesale Prices and Industrial Hygiene. Bulletin U. S. Bureau of Labor, March 3, 1908; 380 pp.

Bi-monthly bulletins regarding labor issued by the Department of Commerce and Labor. Gives the wholesale prices of the staple commodities sold in the U. S. from 1890 to 1907. Under industrial hygiene is discussed the effects of various dirt and dust made in different trades and industries on the health of the men employed, also the chance of accidents to men, and the affect of light upon their eyes. Reports of state bureaus of labor are given, and recent statistical publications on labor issued by foreign countries are reviewed. The book concludes with an index of labor laws of the various dates and decisions relating to them.

Cost of Engineering in Reservoir Construction and Legal Expenses in Condemning Land. Engr.-Contr., July 8, 1908; 2/3 p.

These costs are given for four large reservoirs built in connection with the Croton water supply of the city of New York. Of a total of near ten millions of dollars the engineering expenses were 10 per cent, while for purchasing more than five million dollars' worth of land, the legal expenses were 13 per cent. The legal expenses of land purchased within the city limits were less than that for land bought in the counties.

Comparative Tests of Old and New Manila Rope. Eng. Rec., July 18, 1908; 2/3 p.

Gives an account of a set of tests made to determine the relative strength of old and new ropes. A rope that had been used in erecting four 40-ton girders showed greater strength than a rope that had never been used.

Plans for a Pile Driver Punt. By R. Balfour. Eng. News, July 2, 1908; 1/2 p.

Gives dimensional drawing for and describes method of constructing a punt for pile driver service.

Tests of the Spreading Power of Paints. Eng.-Contr., July 1, 1908; 1/2 p.

Tests were made by painting steel plates, with various surfaces, under exactly similar conditions. Results show amount of paint used, area covered per gallon, cost, time required, etc., etc.

Cost of Operation of Freight and Express Departments on Electric Railways. By F. J. Walsh. Elec. Ry. J., July 4 and 11, 1908; 2 3/4 pp.

Presents itemized table of mileage, earnings, first charges and costs of operation for freight and express service on nine electric railway lines, with text discussion and explanation of the figures.

Public Improvement Assessments. Mun. J. & Eng., July 29, 1908; 1 p.

Data collected from 29 cities by the American Society of Municipal Improvements, showing the methods of computing and collecting special assessments for public improvements and the methods of paying contractors for the same.

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By HOMER A. REID, Assoc. M. Am. Soc. C. E.

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200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter—material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

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An Example of the Economy of Sectional Form Construction.

The economy of designing and constructing forms so that they can be used over and over is now well understood by nearly every builder in concrete, but occasionally an illustration so apt is found that it is worth specific mention. We publish in this issue the labor cost of constructing some 218 concrete vaults or manholes for underground telephone conduit. Incidentally these costs are worthy of note as being the most

complete records of this particular kind of structure that have ever been published outside of Mr. Clarence Mayer's recent book, "Telephone Construction—Methods and Cost."

The 218 vaults were built in seven groups and are so summarized in the article elsewhere. In constructing the vaults for all but one of the groups—namely: group three—sectional wooden forms were used. In this one exceptional group of eleven vaults, a separate wooden form was built for each vault. The cost of placing and removing the forms for the vaults in this group ranged from \$1.40 to \$5 each, and averaged \$4.30 apiece for the eleven. For the remaining vaults, over 200, the corresponding cost averaged \$1.45 per vault. In a word by using sectional forms the labor cost of form work was apparently reduced two-thirds. We say apparently because as a matter of fact poor supervision acted to increase the cost all through the work on this group of vaults and therefore the whole increase in cost of form work is not properly chargeable to the kind of forms used. Assuming, however, that only half of the saving noted above was due to the difference in form construction we still have a reduction of 50 per cent in cost due to using removable sectional forms. This moreover does not take into account any saving in lumber used, which obviously is considerable.

In connection with the above we may properly note that we have before us a comparison of costs of eleven vaults built with sectional wooden forms like those used in the work noted above, and of seventeen vaults built with a collapsible steel form, which shows a material saving due to the steel form. This saving resulted almost wholly from the greater ease in handling the lighter steel form and to the greater ease with which the parts were assembled, adjusted and fastened up. For more extensive work the steel form would show a material saving due to its greater durability.

Legislation for Relief from Engineering Charlatanism.

A correspondent, whose letter we publish in another column, questions the wisdom of the attitude taken in our editorial comment of July 29 on the new Louisiana law requiring the licensing of engineers. We are glad to publish this letter. It describes in forcible language an evil condition of affairs which prevails in the practice of engineering in many states, and it voices an opinion as to the proper remedy for this condition, which is held by a great many engineers. Incidentally the letter invites a defense of our editorial condemnation of legislation attempting to make engineering a close profession.

The truth of the conditions stated by our correspondent cannot be disputed. They exist not only in the states named by him but in more or less virulent form

in every state. There are persons posing as engineers and practicing their calling who are not engineers judged by any recognized professional standard. Many of them are not even competent surveyors. There is no question but that these practitioners are doing harm. Persons and municipalities are hiring them for services which they are incompetent to render and are suffering the burden of the more or less worthless structures which result. There is sound justice in the demand that some method of relief be devised and put in operation. What should be the nature of this relief? The natural answer is that it should be legislation of some sort.

The new Louisiana law is an example of legislation of one sort; it is, we believe, the only example of its sort in the country. Of the value of this law specifically we have already spoken. It makes every person now practicing engineering in the state, whether a charlatan or not, a licensed engineer provided he will only take the small trouble to register his name, and it establishes such license as "conclusive proof of the efficiency of the holder." The law not only does not eliminate the charlatans now practicing engineering in Louisiana, but it legalizes their work and gives them certificates of proficiency. For the future it provides that no one shall take up the practice of engineering until he shall have passed an examination in geometry, trigonometry, land surveying, practical use of instruments and physics. Whether or not he pass in physics, it may be noted, decides whether or not the candidate may call himself a civil engineer or merely a surveyor. Also persons having "a diploma from an engineering college or school of good standing," may have a certificate without passing an examination.

On this showing, as we stated in our previous editorial, we do not feel that the new Louisiana law gives much promise for the future in the way of eliminating incompetent practitioners. True it might shut out the corn planter of which our correspondent speaks, but it would not shut out a high school graduate who has done a little studying on the side and it certainly would not shut out any one of those shrewd scamps now "doing" engineering of whom we and our correspondent and any other engineer can call to mind a number.

Our correspondent urges the charitable view that the present law be welcomed as the "makin's" of a more effective statute. It has been reported, and we presume truly reported, that the new Louisiana law was regarded by its chief sponsor, the Louisiana Engineering Society, as an entering wedge of legislation which would be amended and improved as time went on until a really effective law was secured. If we accept this viewpoint, the question then arises whether any efficient legislation of restrictive character is practicable. Put in different words is it desirable or practicable to make engineering a close profession?

As to the desirability of such action, engineers do not agree among themselves. As to its practicability they are of a still greater variety of opinion. We assume that those who advocate legislation in this matter would urge that ultimately it be universal. Should we have a national law or shall each state have its separate law, and, if the latter be the case, how shall we provide that an engineer licensed in one state may practice in another state? Engineers are migratory creatures. Then, when is a man an engineer? What is engineering, anyway? Shall we give every man, whatever his ability and experience, the same certificate or shall we grade them as first, second and third class? Those questions may sound trivial, but we have heard every one of them raised in a discussion of a proposition to license engineers before the most prominent national engineering society in America, and they do not exhaust the list. It may be desirable and practicable to make engineering a close profession, but we maintain that the burden of proof is on those who advocate such action.

"Meanwhile," it will probably be remarked, "we presume that our public works must be left subject to the practices of the charlatan." We see no reason for this. There are other ways, and to our minds more promising ways, of eliminating charlatanism and incompetency. For example the state of Ohio recently (Eng. Contr., May 6, 1908) enacted a law placing all works for sewage disposal and water purification under the supervision of the State Board of Health. The construction of new works and the operation of old works must satisfy the engineers and sanitarians of the Board of their engineering and sanitary practicability, good design and construction, and efficiency. Other states have similar laws. In England for years all engineering works of public character have been subject to approval in design, construction, etc., by the Local Government Board. The Building Laws of our large cities are of the same type of legislation.

The difference between this sort of legislation and legislation of the sort exemplified by the new Louisiana law is that the engineer's work is subject to inquiry and not the engineer himself. To us this seems the more logical and direct method of regulation if we are to have any sort of regulation. It is not from the fact that John Bumpkin calls himself a civil engineer that the public suffers most, but from the fact that the engineering works of John Bumpkin are more or less worthless. So far at least as works of public service are concerned, supervisory legislation is entirely possible and follows the way of precedent; it will, to our way of thinking, eliminate inefficiency and roguery far more certainly than any practicable law restricting the practice of engineering.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Methods and Labor Cost of Constructing Over 200 Concrete Vaults for Underground Conduit.

Manholes or vaults for underground conduit are among the structures for which

state through suburban towns and country, with a rolling prairie topography, and where the soil was generally sand, clay, and hard clay, with some stretches of quicksand. Special effort was made to secure accurate costs; one or two cost men were

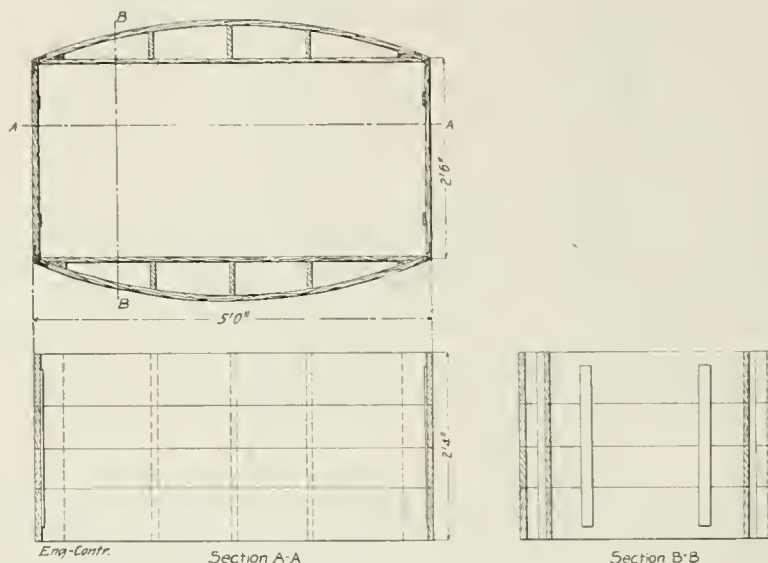


Fig. 1—Sectional Wooden Form for Concrete Vaults.

concrete has somewhat recently begun to be used in place of other materials. Many of our readers will for this reason certainly be interested in the following records of

employed with each gang and all followed a uniform system of collecting and reporting costs. These men were in charge of a special cost statistician to whom they re-

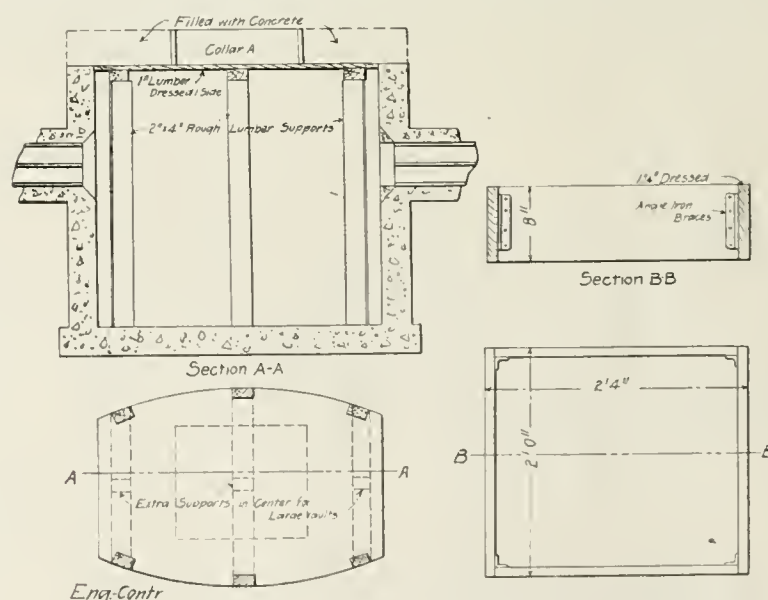


Fig. 2—Top Form for Concrete Vaults.

the cost of constructing some 218 concrete vaults on a single job of conduit work. The work was done in a middle western

ported daily and who had an office on the work and personally watched over and directed the work of cost keeping. As a re-

sult of this care the figures are believed to be as nearly exact as it is possible to obtain them.

Wages.—The wages paid per day of 9 hours were as follows:

Foreman\$3.50 to \$4.00
Assistant foreman\$2.50 to 3.00

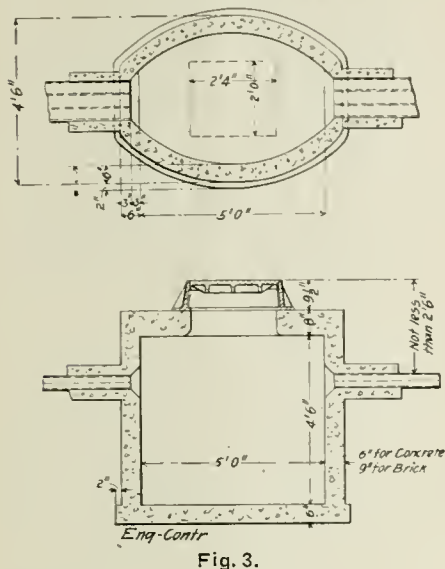


Fig. 3.

Timekeeper\$2.00 to 2.50
Watchmen 2.00
Waterboys 1.00
Laborers 2.00
Teams 5.00

Regular rates were paid for overtime.

Organization.—The work was divided

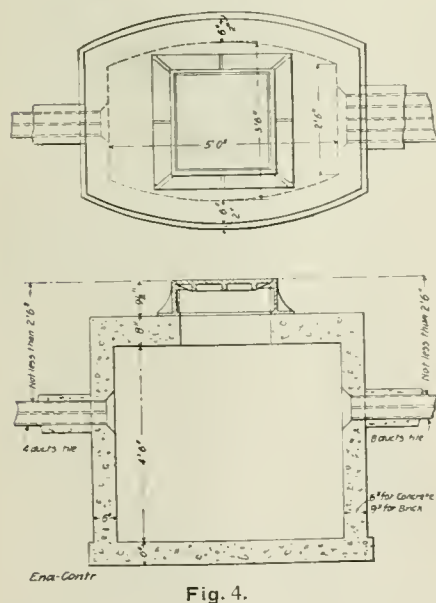


Fig. 4.

into three divisions, and each division was subdivided into two or three sections with a separate gang for each. Each gang did both conduit work and vault work, being subdivided and allotted to the two kinds of work as its foreman deemed advisable. There was an exception to this rule in the case of foreman F, who did only vault work. Foreman A mixed concrete by machines; Foreman B built his vaults a short distance behind the conduit

work and mixed concrete by hand; Foreman C built his vaults along with the conduit and mixed concrete by hand; foreman E built his vaults as close to the conduit work as possible and mixed concrete by machines.

Vaults and Vault Forms. The vaults built were known as sizes 1 and 3, and the dimensions and construction of each are shown by Figs. 3 and 4. The forms used were a sectional wooden form for the sides as shown by Fig. 1 and a top form constructed as shown by Fig. 2. The form for the sides was built in four sections, two sides and two end sections, and for convenience in handling the form was made one-half the height of the vault so that two forms as shown by Fig. 3 were required for each vault. To hold the long sides

from bending in they were braced apart with O'Leary trench braces. The method of using the top form is clearly indicated by Fig. 4.

Costs.—The costs of the work are given in Table I to Table VII, each table covering a group of vaults. The conditions of the work in each case were given briefly in the notes which follow the tables. In general explanation of the tables it should be noted that the costs given in the column headed mixing and placing concrete include the cost of setting the frame and of resurfacing the street. The supervision and expense costs are given separately; they are also included in the other costs by prorating so that the column of total costs actually gives total costs including supervision and expenses.

Table I.—Cost of Constructing 11 Concrete Vaults, Size 3, for Underground Conduit.

No. of vault.	Excavating vault pits.	Placing and removing forms.	Mixing and placing concrete.	Total cost.	Supervision and expenses.	Number of hours worked.
	Teaming.			\$	\$	
1.	6.00	8.88	1.70	8.38	24.96	3.78
2.	8.82	6.66	2.09	18.91	36.48	7.43
3.	9.76	11.10	5.00	21.48	47.34	6.80
4.	6.07	8.60	4.27	32.97	51.91	13.26
5.	9.48	5.57	6.27	14.36	35.68	10.37
6.	20.35	21.04	9.40	20.62	71.41	15.12
7.	13.08	8.90	4.37	21.92	48.27	14.02
8.	11.01	13.56	5.93	18.46	48.96	8.48
9.	10.50	13.58	4.20	17.04	45.32	13.43
10.	5.94	11.22	2.72	16.00	35.88	5.97
11.	3.00	17.42	1.40	12.88	34.70	4.19

Note:—1, 3, 4, 6, 7, 8, 9 and 10, hard clay; 2 and 5, clay, 11, clay and quicksand, four men pumped all day. In all a form was built up for each vault, vaults were built far in rear of conduit work, too much supervision, too many men for the work.

Table II.—Cost of Constructing 47 Concrete Vaults, Size 1, for Underground Conduit.

No. of vault.	Excavating vault pits.	Placing and removing forms.	Mixing and placing concrete.	Total cost.	Supervision and expenses.	Number of hours worked.	
	Teaming.						
1.....	\$ 2.40	\$ 3.04	\$ 0.89	\$ 3.91	\$ 10.24	2.40	36
2.....	2.00	2.03	0.97	3.52	8.52	1.99	31
3.....	2.00	3.05	0.80	4.82	10.67	2.35	38
4.....	2.50	2.34	0.76	4.16	9.76	2.02	33
5.....	2.50	3.12	0.94	5.14	11.70	1.52	39½
6.....	2.50	2.08	1.17	5.79	11.54	1.91	37
7.....	4.00	4.41	0.87	4.91	14.22	1.97	42
8.....	4.00	1.81	0.60	7.41	13.82	2.27	39
9.....	2.00	2.60	0.94	3.95	9.49	2.15	33½
10.....	3.00	6.08	1.08	5.25	15.41	2.68	49
11.....	2.50	2.32	0.89	4.37	10.08	2.70	31
12.....	2.00	3.40	0.57	3.41	9.38	1.59	31
13.....	2.00	3.60	0.85	3.69	10.14	1.69	34
14.....	2.00	4.90	1.54	2.82	11.26	2.42	39
15.....	2.00	7.34	1.04	3.32	13.70	2.92	46
16.....	4.50	9.82	1.08	4.23	19.62	3.17	62
17.....	3.00	4.24	1.17	3.22	11.64	2.80	36
18.....	3.00	2.01	0.82	4.09	9.92	2.36	30
19.....	3.00	5.63	1.24	3.13	13.00	2.58	42
20.....	4.00	6.93	0.55	4.33	15.81	2.49	47
21.....	3.50	4.07	0.57	3.99	12.13	1.75	36½
22.....	3.00	3.74	0.86	2.87	10.47	1.67	30½
23.....	3.00	2.91	0.87	3.18	9.96	1.87	29
24.....	3.00	4.35	0.58	4.62	12.55	2.24	38
25.....	2.50	2.33	0.57	2.85	8.25	2.31	25
26.....	3.00	2.62	0.72	3.14	9.48	2.47	27½
27.....	3.00	2.00	0.58	3.57	9.15	2.48	26½
28.....	3.00	2.27	0.86	4.14	10.29	2.63	30½
29.....	2.50	2.28	0.29	3.71	8.78	2.40	27
30.....	3.00	2.28	0.58	4.85	10.71	2.72	32
31.....	8.27	18.62	0.76	5.87	33.52	9.74	74½
32.....	3.00	6.00	0.79	2.63	12.42	2.33	36½
33.....	3.00	1.85	0.57	5.59	11.01	2.25	31
34.....	3.00	1.71	0.75	4.43	9.89	2.45	25
35.....	3.00	2.16	0.75	4.71	10.68	2.11	29
36.....	3.50	11.40	0.89	3.56	19.35	5.55	51
37.....	4.00	2.20	1.15	4.28	11.63	2.48	28
38.....	3.50	2.34	1.01	4.84	11.69	2.62	29
39.....	4.79	2.46	1.03	4.06	12.34	2.75	30
40.....	4.00	2.31	1.02	5.93	13.26	2.15	37
41.....	4.50	2.46	1.02	5.81	13.79	2.30	36½
42.....	3.50	1.85	1.20	8.16	14.71	2.98	41½
43.....	3.52	2.62	0.73	4.63	11.50	2.73	28½
44.....	3.25	2.04	1.09	5.54	11.92	3.13	30
45.....	2.25	3.33	0.94	4.48	11.00	3.71	27½
46.....	2.25	3.74	1.14	4.53	11.66	4.06	27
47.....	2.25	2.71	0.73	5.81	11.53	3.83	29½
Totals.....	145.98	179.42	40.82	207.38	573.60	126.29	1,672
Averages.....	3.11	3.82	0.87	4.41	12.20	2.69	35.6

Note:—1 to 6, sand; 7, sand, caved and had to sheet; 8 and 9, sand; 10, sand, caved and had to sheet; 11 to 14, sand; 15 and 16, water and quicksand, had to sheet; 17, sand, 18 and 19, caved in; 20, sand, caved in, had to sheet; 21, sand, caved in; 22 and 23, sand; 24, sand, had to sheet; 25 to 30, sand; 31, quicksand and spring, had to build crib; 32, sand, caved in and had to sheet; 33 to 35, sand; 36, quicksand and spring, had to sheet and pump; 37 to 47, sand.

Table III.—Cost of Constructing 6 Concrete Vaults, Size 3, for Underground Conduit

No. of vault.	Teaming.	Excavating vault pits.	Placing and removing forms.	Mixing and placing concrete.	Total cost.	Supervision and expenses.	Number hours worked.
1.....	\$ 1.00	\$ 3.99	\$ 1.18	\$ 4.61	10.78	\$ 2.51	36
2.....	1.00	6.51	0.74	5.63	13.88	3.75	51.5
3.....	1.00	5.13	0.84	2.56	9.53	2.19	31
4.....	2.00	2.57	0.58	2.46	7.61	1.34	21.5
5.....	1.50	5.55	1.18	2.06	10.29	2.42	35
6.....	2.00	4.04	2.23	2.46	10.73	2.22	35
Totals.....	8.50	27.79	6.75	19.78	62.82	14.43	210
Averages.....	1.42	4.63	1.12	3.29	10.47	2.41	35

Note:—The spoil from the pits was scattered over the adjoining ground. The soil excavated was for vault 1, clay; vaults 2, 3, 5 and 6, hard clay; vault 4, loam and clay.

Table IV.—Cost of Constructing 14 Concrete Vaults, Size 3, for Underground Conduit.

No. of vault.	Teaming.	Excavating vault pits.	Placing and removing forms.	Mixing and placing concrete.	Total cost.	Supervision and expenses.	Number hours worked.
1.....	\$ 4.56	\$ 13.49	\$ 1.39	\$ 5.29	24.73	\$ 5.58	62.5
2.....	5.65	5.46	1.35	8.17	20.63	4.27	58
3.....	4.60	7.05	1.35	6.68	19.68	4.29	56
4.....	4.60	8.39	6.78	16.04	35.81	10.53	96
5.....	5.50	7.89	3.89	9.69	26.97	8.87	58
6.....	3.50	4.60	1.40	5.48	14.98	3.89	35
7.....	4.20	3.56	4.21	11.32	23.29	9.55	48
8.....	7.00	6.20	1.61	5.76	20.57	5.46	42
9.....	5.00	2.86	1.12	4.62	13.60	2.57	30
10.....	3.00	6.70	1.93	3.53	15.46	3.66	38
11.....	2.50	5.29	2.22	4.84	14.85	3.90	38
12.....	2.50	8.86	1.37	9.75	22.48	8.14	55
13.....	3.00	5.52	1.57	8.59	18.68	6.09	44
14.....	1.50	5.00	2.31	8.45	17.26	6.11	44
Totals.....	57.11	90.87	32.50	108.21	288.69	82.91	704.5
Averages.....	4.08	6.49	2.32	7.73	20.62	5.92	50.32

Note:—1, 2, 3 and 5, sticky, wet clay, had to pump; 4, ditto, caved while placing bottom; 6, 7 and 8, hard clay, had to pump; 9, clay; 10 and 11, hard clay, 12, wet clay, had to pump; 13 and 14, hard clay, had to pump.

Table V.—Cost of Constructing 57 Concrete Vaults, Size 1, for Underground Conduit

No. of vault.	Teaming.	Excavating vault pits.	Placing and removing forms.	Mixing and placing concrete.	Total cost.	Supervision and expenses.	Number hours worked.
1.....	\$ 3.99	\$ 4.02	\$ 1.21	\$ 6.34	15.56	\$ 1.05	45½
2.....	3.30	3.07	2.06	9.92	18.35	1.38	61½
3.....	2.55	3.43	0.98	6.13	13.09	0.99	43
4.....	2.80	2.75	1.70	6.21	13.46	1.13	51
5.....	3.14	4.88	1.93	5.44	15.39	0.95	50½
6.....	2.14	2.88	1.93	3.12	10.07	0.75	33
7.....	2.22	3.50	2.23	4.45	12.40	1.42	38¼
8.....	2.22	2.55	2.23	3.48	10.48	1.18	31¾
9.....	2.69	2.82	2.34	5.25	13.10	1.50	40½
10.....	5.08	15.98	8.93	6.80	36.79	3.40	119½
11.....	3.31	1.96	5.98	6.16	17.41	1.45	57
12.....	3.06	1.33	1.58	3.77	9.74	0.60	26
13.....	3.06	3.04	1.82	3.67	11.59	0.77	33½
14.....	5.13	13.53	6.03	10.87	35.56	2.86	125
15.....	3.93	1.46	1.75	3.50	10.64	0.71	26
16.....	3.75	1.97	1.22	5.59	12.53	0.76	36
17.....	2.17	1.97	1.47	2.73	8.34	0.62	26½
18.....	2.40	1.47	1.23	3.75	8.85	0.70	27
19.....	3.15	1.97	1.23	3.75	10.10	0.74	29
20.....	2.97	1.18	1.63	3.53	9.31	0.69	25½
21.....	2.97	1.65	1.50	3.28	9.40	0.50	25½
22.....	2.69	1.72	1.73	3.48	9.62	0.66	27½
23.....	2.83	1.74	1.01	5.02	10.60	0.70	26½
24.....	2.97	1.42	1.26	4.53	10.18	0.75	28
25.....	3.38	1.17	1.97	4.35	10.87	1.03	28½
26.....	2.63	3.22	1.10	3.35	10.30	1.20	37½
27.....	3.21	3.77	1.85	3.10	11.93	1.29	46½
28.....	3.59	3.87	1.60	6.34	15.40	1.49	42
29.....	2.95	3.24	1.60	5.50	13.29	1.59	34½
30.....	4.45	5.00	1.95	2.84	14.24	1.85	36
31.....	3.65	2.00	0.65	3.86	10.16	0.83	26½
32.....	3.96	3.45	2.35	3.07	12.83	1.34	34
33.....	4.45	3.83	3.00	4.43	15.71	1.95	43½
34.....	2.83	2.98	1.78	4.79	12.38	1.39	31½
35.....	5.23	4.13	1.55	3.12	14.03	1.80	40
36.....	4.00	2.45	2.12	2.70	11.45	1.12	28
37.....	3.19	4.45	1.27	4.12	13.03	1.56	39½
38.....	3.34	4.75	0.54	2.51	11.14	0.93	30
39.....	4.11	2.72	1.42	4.00	12.25	2.02	34
40.....	3.55	5.16	1.42	5.51	14.96	3.72	30½
41.....	3.45	3.55	0.74	5.07	12.81	3.35	27
42.....	5.26	7.20	1.30	4.21	17.97	5.35	33
43.....	5.95	4.23	0.90	5.20	16.28	2.77	34
44.....	3.44	3.11	0.80	3.00	10.35	0.89	30
45.....	3.68	2.38	1.05	6.13	13.24	3.11	29
46.....	3.48	2.38	1.05	6.20	13.11	3.41	28
47.....	2.72	2.97	1.11	6.50	13.30	3.64	31
48.....	2.73	2.88	1.11	7.68	12.72	3.54	29
49.....	5.47	4.73	1.68	7.68	19.56	5.41	39
50.....	6.86	3.60	2.79	6.89	20.14	4.26	41½
51.....	7.41	8.75	2.57	9.96	28.69	9.16	48
52.....	5.37	7.54	1.26	6.31	20.48	5.05	43
53.....	5.23	3.00	2.89	12.68	23.80	9.06	44
54.....	5.27	2.54	0.69	5.46	13.96	1.38	33
55.....	5.19	3.67	2.09	9.25	20.20	5.20	57
56.....	4.74	4.86	1.31	4.59	15.50	1.76	43
57.....	4.84	3.00	0.92	4.78	13.54	2.21	29
Totals.....	214.22	208.37	104.73	294.86	\$221.82	120.92	2,214½
Averages.....	3.76	3.66	1.84	5.17	14.42	2.12	38.85

Note:—1, sand; 2, sand, caved in while placing concrete; 3 and 4, sand; 5, quicksand and water, caved in; 6 to 8, sand; 9, 1 ft. deeper than specifications; 10, excavated by mistake for size 10 vault, had to sheet; 11, sand, caved in while placing form; 12 and 13, sand; 14, quicksand and water, caved in, had to sheet 15 to 29, sand; 30, sand, had to pump; 31, sand; 32 to 38, sand, had to pump; 39, sand; 40, quicksand and water; 41, sand; 42, quicksand and water, had to sheet; 43 to 48, sand, caved in; 49 to 53, quicksand and water, springs in bottom, very difficult; 54, sand; 55 to 57, sand, ruined.

Tests of Bond of Steel Embedded in Reinforced Concrete Beams.*

This paper is a report of tests made on the bond between concrete and plain round mild steel reinforcing bars. These tests were made in the Materials Testing Laboratory at the University of Wisconsin during the spring and summer of 1907.

The subject of bond between concrete and steel has led to many extensive series of tests. Most of these tests have been made by embedding a rod in the center of a cylindrical block of concrete and pulling it out in such a way that the concrete around the rod was compressed. In general, the results of such tests have neither given conclusive nor reliable data upon which working values for structural purposes can be based.

In order to approximate more closely the actual conditions in reinforced concrete beams, a different form of bond specimen was used in the tests herein described and the results compared with those obtained from the ordinary cylinder test. The larger portion of the specimens were made and tested as thesis work by Messrs. A. B. Carey, S. L. Clark and P. B. Johnson, of the class of 1907, to whom due acknowledgment is hereby made.

The sand used in these tests was a rather fine local bank sand. It weighed 103 lbs. per cu. ft., measured loose, contained 37.5 per cent voids and 3 per cent of fine dirt.

The limestone used was obtained from Kankakee, Ill. It would pass a 1-in. mesh, weighed 83 lb. per cu. ft. and contained 48.5 per cent voids. A local bank gravel was used in beams 19 and 20, particles less than 0.2 in. in diameter being screened out. It weighed 105 lbs. per cu. ft. and contained 35½ per cent voids.

The Atlas cement from Missouri took an initial set in 45 mins., final set in 5 hrs. and 40 mins. and satisfactorily passed the pat tests. At 7 and 28 days the average strength of four neat briquettes was 529 and 659 lbs. per sq. in., respectively. The strength of the 1:3 mortar briquettes increased from 204 lbs. per sq. in. at 7 days to 309 lbs. per sq. in. at 28 days. Plain round mild steel rods with an elastic limit of about 44,000 lbs. per sq. in., an ultimate strength of approximately 64,000 lbs. per sq. in. and a modulus of elasticity averaging about 30,000,000 lbs. per sq. in. were used as reinforcement in the test pieces. These rods were free from rust and loose scales.

The concrete for beams 1 to 49 was mixed by hand on the cement floor in the laboratory. The rest of the beams were mixed by machine. Materials were proportioned by volume. Quantities required were weighed on a platform scale. The weight of the cement was assumed to be 100 lbs. per cu. ft.

Three consistencies were used in beams 23 to 31, wet, medium and dry. The wet

*Abstract of a paper presented at the convention of the American Society for Testing Materials, by Mr. Morton O. White, Madison, Wis.

concrete was sloppy, could not be piled up on the mixing floor, and when placed in the molds showed an excess of water on top. The medium concrete when piled on the floor would flatten out, could be readily worked around the reinforcement without much tamping and was easily surfaced with a trowel. The dry concrete was very mealy, would stand piled up on the floor, required hard tamping and could not be readily surfaced with trowel. The medium consistency was used in all other beams.

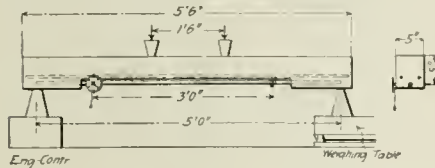


Fig. 1.

The form of specimen adopted for determining the bond in beams is shown in Fig. 1. These beams were in general 5 ft. 6 ins. long and 5 ins. wide and 6 ins. deep. They were so made that the central portion of the lower rod, whose bond was to be obtained, was exposed. The two $\frac{3}{8}$ in. round rods seen in the figure were placed above the exposed bar to distribute the tension cracks and prevent failure in the concrete before the lower rod slipped. Wooden forms were used in making beams 1 to 49, steel forms in the remainder.

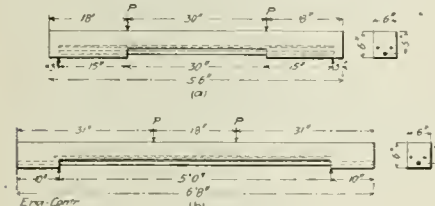


Fig. 2.

In beams, the exposure of the lower rod was secured by covering it with damp sand before the concrete was placed. A notched piece of wood placed transversely with respect to the axis of the beam served to space the rod and provide a definite limit for the predetermined length of embedment. The embedment used for all beams with lower rod $\frac{3}{8}$ in. in diameter or larger was approximately 10 ins. except in beams 62, 63 and 64, where it was approximately 15 ins. The embedment of the lower $\frac{3}{8}$ -in. rod in beams 38, 39 and 40 was nearly $7\frac{1}{2}$ ins. and that of the $\frac{1}{2}$ -in. rod in beams 41, 42 and 43 about $8\frac{1}{2}$ ins. After each test, the actual length of embedment of the end at which slipping occurred was carefully measured. This quantity was then used in obtaining the results given in the tables.

Auxiliary compression specimens consisting of 4-in. cubes or cylinders 6 ins. in diameter and 18 ins. long were made with nearly every batch of concrete as indicated in Table I. The bond cylinders were also cast from the same batch of concrete as the corresponding beams. In all cases they were made with the rod vertical and an embedment of practically 12 ins.

Table VI.—Cost of Constructing 25 Concrete Vaults, Size 3, for Underground Conduit.

No. of vault.	Excavating vault pits.	Placing and removing forms.	Mixing and placing concrete.	Total cost.	Supervision and expenses.	Number hours worked.
	\$	\$	\$	\$	\$	
1.....	2.00	7.16	2.02	10.74	7.37	68
2.....	4.99	7.12	2.16	9.13	8.44	67
3.....	13.65	6.60	1.43	13.33	9.96	76
4.....	12.13	6.83	1.43	12.52	9.34	71½
5.....	4.75	5.12	0.89	6.16	5.22	39
6.....	4.93	5.53	1.23	8.68	5.94	60
7.....	4.43	5.12	1.23	10.64	5.20	57
8.....	3.02	5.30	0.73	7.49	6.18	52
9.....	5.33	4.96	1.57	9.79	5.86	62
10.....	5.02	5.27	1.69	8.82	5.32	52
11.....	5.46	5.58	1.69	10.49	6.83	67
12.....	5.36	4.96	1.68	10.25	6.48	55
13.....	3.96	4.58	2.05	7.19	17.78	4.34
14.....	4.27	4.83	1.40	9.18	19.68	5.96
15.....	3.97	5.19	1.68	6.20	17.04	3.99
16.....	3.47	5.49	1.04	9.07	19.07	5.71
17.....	3.99	4.82	1.04	8.99	18.84	6.49
18.....	4.76	4.83	1.04	8.95	19.58	5.46
19.....	4.10	6.24	1.10	10.81	22.25	6.82
20.....	4.55	6.22	1.10	10.31	22.18	6.27
21.....	3.81	6.37	1.10	10.31	21.57	6.47
22.....	4.00	6.12	1.13	10.30	21.55	6.09
23.....	4.21	6.72	1.08	10.31	22.32	6.45
24.....	4.75	6.66	1.37	5.85	18.63	5.43
25.....	4.60	5.58	1.37	7.45	19.00	5.62
Totals.....	125.51	149.20	34.24	232.96	541.91	1,344.6
Averages.....	5.02	5.58	1.37	9.31	21.67	53.8

Note:—All vault pits in.

Table VII.—Cost of Constructing 58 Concrete Vaults, Size 3, for Underground Conduit.

No. of vault.	Excavating vault pits.	Placing and removing forms.	Mixing and placing concrete.	Total cost.	Supervision and expenses.	Number hours worked.
	\$	\$	\$	\$	\$	
1.....	2.95	2.73	1.54	5.63	12.85	1.26
2.....	2.00	5.22	1.03	4.34	12.59	2.16
3.....	1.55	3.26	1.25	3.62	9.68	1.83
4.....	2.10	11.22	4.18	5.28	22.78	3.52
5.....	1.55	5.99	1.23	4.14	12.91	2.55
6.....	1.55	4.00	0.80	4.06	10.41	2.78
7.....	1.55	4.45	0.88	3.56	10.44	3.52
8.....	1.55	4.49	1.00	4.41	11.45	2.55
9.....	2.00	3.31	1.24	4.14	10.69	2.02
10.....	2.10	4.62	1.40	4.87	12.99	3.07
11.....	2.10	4.40	1.20	4.75	12.45	2.87
12.....	2.00	4.46	1.54	4.85	12.85	2.91
13.....	2.10	5.26	0.95	4.40	12.71	3.06
14.....	5.00	2.53	0.91	11.56	20.00	3.35
15.....	5.00	4.30	1.16	10.10	20.56	3.31
16.....	1.00	2.59	1.79	9.36	14.74	4.30
17.....	1.50	10.07	1.14	9.49	22.20	5.97
18.....	1.50	4.98	1.18	10.20	17.86	4.90
19.....	5.66	4.70	2.10	6.65	19.11	2.20
20.....	4.09	4.10	1.18	5.10	14.47	2.98
21.....	4.98	4.70	0.20	5.90	15.78	2.53
22.....	5.91	5.40	0.24	4.65	16.20	3.01
23.....	5.90	6.87	0.65	8.57	21.99	2.54
24.....	5.91	7.56	0.90	6.76	21.13	2.54
25.....	5.42	4.73	1.10	6.69	17.94	2.04
26.....	5.50	3.82	0.80	8.29	18.51	2.04
27.....	4.88	6.25	2.30	10.61	24.04	2.23
28.....	5.46	5.95	1.09	7.87	20.37	2.28
29.....	4.74	5.85	1.09	10.23	21.91	3.55
30.....	5.43	3.26	1.44	9.17	19.30	2.21
31.....	4.00	4.86	2.81	21.88	33.55	6.70
32.....	2.98	4.05	1.31	9.70	19.04	3.13
33.....	6.76	5.38	0.73	9.87	20.74	2.80
34.....	4.93	4.86	0.69	7.55	18.03	2.02
35.....	4.75	9.52	1.02	11.55	26.84	6.12
36.....	7.40	8.17	1.58	9.94	27.09	5.46
37.....	4.35	7.20	1.92	10.96	24.43	6.34
38.....	3.98	5.60	0.78	7.98	18.34	3.32
39.....	3.05	5.59	0.90	7.85	17.39	2.25
40.....	2.48	4.64	0.91	7.51	15.54	2.08
41.....	4.28	6.64	2.39	8.89	22.20	5.20
42.....	4.03	6.49	1.50	9.25	21.27	5.19
43.....	2.08	6.92	1.83	9.84	20.67	5.55
44.....	2.53	5.59	1.22	7.62	16.96	3.86
45.....	4.27	7.28	0.62	5.03	17.20	3.95
46.....	3.70	4.68	1.23	6.14	15.75	2.47
47.....	3.19	4.72	2.36	11.17	21.44	5.32
48.....	3.18	4.66	1.54	6.57	15.95	3.59
49.....	4.15	4.57	1.88	7.15	17.75	2.99
50.....	3.24	4.39	2.01	8.79	18.43	3.79
51.....	3.05	5.13	1.24	7.31	16.73	4.97
52.....	3.38	6.04	1.48	6.92	17.82	4.00
53.....	3.42	5.82	1.78	8.14	19.16	4.91
54.....	3.72	7.96	1.85	8.23	21.76	4.78
55.....	3.21	6.36	1.89	9.11	20.57	4.69
56.....	2.90	5.12	2.28	9.26	19.56	5.19
57.....	2.13	9.60	1.42	5.18	18.33	6.36
58.....	2.14	9.60	3.14	3.63	18.51	6.31
Totals.....	207.26	322.51	81.82	440.37	1,051.96	2,743
Averages.....	3.57	5.56	1.41	7.59	18.13	47.3

Note:—1, clay; 2 and 3, hard clay; 4, quick sand and water, had to sheet; 5 to 12, hard clay; 13, hard clay 8 ft. deep; 14, sand; 15, clay and sand, surplus earth scattered; 16, clay and sand, surplus earth scattered; 17, hard clay, surplus earth scattered; 18 to 22, hard clay, surplus earth scattered; 23, hard clay, had to move vault after excavating 3 ft. deep; 24 to 25, hard clay; 26, clay; 27, hard clay, excavating 2 ft. deep; 28 to 30, hard clay; 31, hard clay, had to pump on account of rain; 32 to 34, hard clay; 35, hard clay, had to pump, form warped; 36 to 39, hard clay; 40 and 41, hard clay, had to pump; 42, hard clay, had to pump; 43 to 46, hard clay; 47, wet clay, form broke; 48 to 51, wet clay; 52 and 53, hard clay; 54 to 56, hard clay, rain, had to pump; 57 and 58, very hard clay.

Beams 1 to 19 were kept in the molds for at least three days after mixing. They were then allowed to cure without being dampened until tested. Beams 50 to 61 were kept in the forms two days and sprinkled every day for a week after mixing. Beams 62, 63 and 64 were kept in the forms three days and sprinkled twice a day until tested. This continued wetting may have weakened their bond strength. Table I. gives the general data on the 56 beams which were made.

All beams were tested over a 5-ft. span. All beams except 62, 63 and 64 were loaded as shown in Fig. 1. Fig. 2 (b) indicates how beams 62, 63 and 64 were loaded and also shows the different shape adopted for beams 58 to 61. Loads were applied in increments of 200 or 300 lbs. and readings of the deformation in the rod taken on the extensometer.

The deformation of the rod was measured by a dial extensometer reading to 0.0001 of an inch.

The rods embedded in cylinders were pulled out by a universal 50,000-lb. testing machine. The pulling head was raised so

Table III contains the results of bond tests made on different mixes. The bond for the 1:3:6 mix was decidedly lower than the others. It will also be noted that the compressive strength of this mix was only about half that of the other mixes. There was very little difference in the average bond of 1:2:4 limestone, 1:2:4 gravel and 1:2½ mortar.

TABLE II. EFFECT OF TIME ON THE BOND OF 1:2:4 CONCRETE.

Beam No.	Maximum load, lb.	Age.	Stress in steel, lb./in. ²	Bond, lb./in. ²	Compressive strength of concrete, lb./in. ²
1....	4,000	7 da.	14,206	222	.....
2....	3,400	7 da.	13,500	211	.....
3....	Beam accidentally destroyed.				
Aver.	.....	7 da.	.....	216	1,400
4....	6,800	28 da.	23,000	305	.....
5....	4,400	28 da.	19,200	312	2,030
6....	4,603	28 da.	12,900	207	.....
54....	4,500	28 da.	14,500	228	.....
55....	4,500	28 da.	15,900	248	.....
56....	4,300	28 da.	14,100	222	1,630
57....	5,000	28 da.	16,300	247	.....
Aver.	.....	28 da.	.....	253	1,860
7....	4,800	60 da.	18,500	362	.....
8....	4,200	60 da.	16,900	264	.....
9....	4,000	60 da.	11,100	201	.....
Aver.	.....	60 da.	.....	276	1,730
10....	4,200	6 mos.	17,900	280	.....
11....	5,200	6 mos.	21,300	350	.....
12....	4,800	6 mos.	16,800	318	.....
Aver.	.....	6 mos.	.....	316	1,630

TABLE I.—DATA OF SPECIMENS MADE.

Beam No.	Mix.	Consistency.	Size of Rod.	Age.	Variable Studied.	Kind of Auxiliary Specimens.
1-2-3.....	1:2:4	medium	5/8 in.	7 da.	time	compression
4-5-6.....	1:2:4	medium	5/8 in.	28 da.	time	compression
7-8-9.....	1:2:4	medium	5/8 in.	60 da.	time	compression
10-11-12.....	1:2:4	medium	5/8 in.	6 mos.	time	compression
13-14-15.....	1:2:4	medium	5/8 in.	60 da.	mix	compression
16-17-18.....	1:3:6	medium	5/8 in.	60 da.	mix	compression
*19-20.....	1:2:4	medium	5/8 in.	60 da.	mix	compression
21-22.....	1:2½	medium	5/8 in.	60 da.	mix	compression
23-24-25.....	1:2:4	wet	5/8 in.	60 da.	consistency	.....
26-27-28.....	1:2:4	medium	5/8 in.	60 da.	consistency	.....
29-30-31.....	1:2:4	dry	5/8 in.	60 da.	consistency	.....
32-33-34.....	1:2:4	medium	5/8 in.	60 da.	method of test	bond
35-36-37.....	1:2:4	medium	5/8 in.	60 da.	size of rods	bond
38-39-40.....	1:2:4	medium	5/8 in.	60 da.	size of rods	bond
41-42-43.....	1:2:4	medium	1 1/2 in.	60 da.	size of rods	bond
44-45-46.....	1:2:4	medium	1 1/2 in.	60 da.	size of rods	bond
47-48-49.....	1:2:4	medium	1 in.	60 da.	size of rods	bond
50-51-52.....	1:2:4	medium	5/8 in.	28 da.	time & load	g. compres'n
53-54-55.....	1:2:4	medium	5/8 in.	28 da.	loading	compression
56-57-58.....	1:2:4	medium	5/8 in.	29 da.	loading	compression
62-63-64.....	1:2:4	medium	5/8 in.	29 da.	loading	compression

*In 19 and 20 gravel was used in place of limestone.

that the projecting part of the rod could be run up through it and gripped by the wedges in the upper head. If the top of the cylinder was uneven, blotting paper was inserted between it and the pulling head to equalize the pressure. No allowance was made for the area of the hole in the pulling head, 8 sq. ins. in computing the stresses in Table VII.

To calculate the bond in a beam from the deformation of the rod, the following formula was used:

$$B = r d E \div 8 L l$$

where B = bond in pounds per square inch, r = dial reading plus zero correction, d = diameter of rod in inches, E = 30,000,000 lbs. per square inch, L = gage length of extensometer, and l = length of embedment of rod.

In Table II are given the results of beam tests to determine the effect of time upon the bond. Although there was a considerable variation from the mean at some of the ages, the average bond increased with the age of the specimen.

TABLE III. COMPARISON OF THE BOND OF VARIOUS MIXES. AGE 60 DAYS.

Beam No.	Mix.	Maximum load, lb.	Stress in steel, lb./in. ²	Bond, lb./in. ²	Compressive strength of concrete, lb./in. ²
7....	1:2:4	4,800	18,500	362	.....
8....	1:2:4	4,200	16,900	264	.....
9....	1:2:4	4,000	11,100	201	.....
Aver.	1:2:4	.....	.....	276	1,730
17....	1:3:6	2,200	11,600	181	.....
18....	1:3:6	4,400	18,100	251	.....
Aver.	1:3:6	.....	.....	216	830
19....	1:2:4 g.	5,200	19,900	282	.....
20....	1:2:4 g.	4,800	17,200	269	.....
Aver.	1:2:4 g.	.....	.....	275	2,200
21....	1:2½	3,600	16,600	235	.....
22....	1:2½	3,800	18,200	300	.....
Aver.	1:2½	.....	.....	267	1,600

TABLE IV. EFFECT OF DIFFERENT CONSISTENCIES ON THE BOND OF 1:2:4 CONCRETE.

Beam No.	Consistency.	Maximum load, lb.	Stress in steel, lb./in. ²	Bond, lb./in. ²
23.....	wet	3,200	11,000	180
24.....	wet	1,800	22,100	346
25.....	wet	4,000	16,500	224
Average	wet	.....	.....	250
26.....	medium	3,200	11,500	171
27.....	medium	3,600	18,500	321
28.....	medium	3,500	13,600	212
Average	medium	.....	.....	235
29.....	dry	4,800	19,500	287
30.....	dry	3,600	20,100	311
31.....	dry	3,600	13,600	224
Average	dry	.....	.....	273
Age of specimens, 60 days.				

The data for tests upon wet, medium and dry consistencies in Table IV indicate that the amount of water used in these tests had no decided effect on the bond when the specimens were 60 days old.

TABLE V.—EFFECT OF SIZE OF ROD ON THE BOND OF 1:2:4 CONCRETE. AGE, 60 DAYS.

Beam No.	Size of rod.	Maximum load, lb.	Stress in steel, lb./in. ²	Bond, lb./in. ²
38.....	3/8 in.	3,200	27,600	345
39.....	3/8 in.	3,400	25,800	298
40.....	3/8 in.	2,400	16,700	190
Average.	3/8 in.	.....	.....	278
41.....	1/2 in.	4,400	26,400	361
42.....	1/2 in.	3,600	21,200	312
43.....	1/2 in.	2,800	12,300	186
Average.	1/2 in.	.....	.....	286
44.....	3/4 in.	4,800	18,500	362
45.....	3/4 in.	4,200	16,900	264
46.....	3/4 in.	4,000	11,100	201
Average.	3/4 in.	.....	.....	276
47.....	1 in.	5,000	12,400	207
48.....	1 in.	4,400	13,900	239
49.....	1 in.	4,000	15,700	295
Average.	1 in.	.....	.....	264
50.....	1 in.	3,400	5,850	136
51.....	1 in.	4,000	7,650	174
52.....	1 in.	4,000	7,900	180
Average.	1 in.	.....	.....	163

From Table V it appears that the size of the rod up to 1-in. diameter has but little influence on the bond. The specimens with the 1-in. rod showed a marked decrease in bond. More bond tests with this size of bar are necessary before this decrease can be satisfactorily accounted for.

Beams 54 to 61 were made to determine the effect on bond of embedding the rod in stressed and unstressed concrete. Beams 54 to 57 were made and loaded, as shown in Fig. 1. The results apparently indicate that the bond of concrete subjected to a tensile stress is considerably greater than that of concrete which is practically unstressed. It is possible that bending increased the resistance against slipping in the first four of these beams. It will be observed also that compressive strength of the concrete for beams 54 to 57 was considerably higher than that tested from beams 58 to 61.

TABLE VI.—MISCELLANEOUS TESTS ON THE BOND OF 1:2:4 CONCRETE.

Beam No.	Maximum load, lbs.	Stress in steel, lbs./in. ²	Bond, lbs./in. ²	Compressive strength of concrete, lbs./in. ²
54.....	4,500	14,500	228	.....
55.....	4,500	15,900	248	.....
56.....	4,300	14,100	222	.....
57.....	5,000	16,300	247	.....
Average.	.....	.....	236	1,690
58.....	3,400	8,800	129	.....
59.....	3,300	9,500	141	.....
60.....	4,100	12,600	187	.....
61.....	3,900	13,700	204	.....
Average.	.....	.....	165	1,070
62.....	6,850	19,000	197	.....
63.....	6,800	20,300	215	.....
64.....	7,000	22,100	236	.....
Average.	.....	.....	216	2,315

Beams 62, 63 and 64 were designed to determine the effect of a change from the standard loading, shown in Fig. 1. They were made and loaded as shown in Fig. 2 (a). The average bond of these beams did not differ materially from that obtained from beams 54 to 57. The small decrease in bond developed in 62, 63 and 64 might have been due to the fact that they were sprinkled more frequently while curing

than the other beams. This might have decreased the shrinkage of the concrete and thereby lessened the bond.

If the bond stress be computed in the ordinary way from the average vertical shear of beams 62, 63 and 64, a value of 214 lbs. per square inch will be obtained. In making this computation the arm of the resisting couple was taken as 0.82 times the effective depth. The distance from the top of the beam to the $\frac{3}{8}$ -in. rods was $3\frac{3}{4}$ ins. This quantity checks very closely the average value obtained from the deformation of the lower rod, 216 lbs. per square inch.

TABLE VII.—COMPARISON OF BEAM AND CYLINDER TESTS ON BOND.

Beam No.	Size of rod, ins.	Average bond in beam, lbs./in. ²	Average bond in cylinders, lbs./in. ²	Bond in cyl. ÷ bond in beam.	Compressive stress on top of bond cyl., lbs./in. ²
38-39-40....	$\frac{3}{8}$	278	394	1.42	197
41-42-43....	$\frac{1}{2}$	286	455	1.54	317
62-63-64....	$\frac{5}{8}$	216	311	1.44	252
36-37....	$\frac{3}{8}$	266	467	1.76	395
44-45-46....	$\frac{3}{8}$	264	502	1.90	495
47-48-49....	1	163	487	2.99	629

A comparison between the bond developed in beams and that obtained in bond cylinders made at the same time is afforded in Table VII. Column 5, headed Bond in Cylinder ÷ Bond in Beam, shows that the cylinder tests gave bond stresses from 1.42 to 2.99 times as large as those obtained from the beam tests.

Conclusions.—1. The bond of 1:2:4 concrete to embedded steel increases with age at least up to six months. About 80 per cent of its six months bond strength is developed at 28 days.

2. Owing to the variation in results of the one-month tests, and the wide difference between laboratory experiments and practical working conditions, it does not seem as though the maximum bond of 1:2:4 concrete should be assumed greater than 200 or 250 lbs. per square inch in designing.

3. The method of making bond tests by pulling a rod from a concrete cylinder, as previously described, gives results which are of neither quantitative nor qualitative value. The results obtained are dependent largely upon compressive stress acting on the head of the cylinder.

4. The beam test for bond on the other hand approaches closely the actual conditions to which the bar and surrounding concrete are most often subjected, and gives values which are at least of qualitative value. Furthermore, values obtained by this method are in accord with the bond theory usually accepted as a basis in design.

The Transcontinental Railway Commissioners of Canada are calling for bids for supplying 44,500 tons of 80-lb. steel rails

The first train was run through the Market street subway of Philadelphia, Pa., on Aug. 3.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of a Culvert Excavation on a Railroad.

In a recent issue of this journal* we published the cost of making the excavation for a culvert, the material being wet. At that time we commented upon the fact that in railroad construction this class of work is paid for at the same rates as work done in the cuts, in spite of the fact that it is generally more expensive. We give another example of the cost of such work, showing that it is a costly class of excavation.

This job was done on some railroad construction in Tennessee. The culvert was a 4x4 box culvert of rubble masonry, 42 ft. long. The excavation was 12 ft. wide and $2\frac{1}{2}$ ft. deep. The material excavated was a dry sandy clay that was easily worked, although it had to be picked before it could be shoveled. When material in culvert excavation can be spaded, thus saving the picking, the work can be done much cheaper.

The excavated material in this case was shoveled on to the ground on either side of the culvert, the ends, naturally being left open. At each end of the culvert a ditch 4 ft. wide was cut to the culvert excavation, making 53 cu. yds. of excavation for the culvert and ditches. This earth piled up on the two sides of the pit would make about 65 cu. yds. loose measurement, making it necessary to handle some of the material a second time. This fact and likewise the width of the pit, 12 ft., meant that the men had to cast the earth some distance, thus adding to the cost of the work. At least half the material was handled a second time, and about 10% was handled three times.

The cost of the work was as follows:

Foreman, 3 days @ \$2.50.....\$ 7.50
Laborers, 25 days @ \$1.25..... 31.25
Water boy, 3 days @ \$0.50..... 1.50

Total\$10.25

This gave cost of the following per cubic yard:

Foreman\$0.11
Laborers 0.59
Water boy 0.03

Total\$0.76

A man excavated, that is picked and shoveled, about 2 cu. yds. per day, of the original excavation, or about $3\frac{1}{2}$ cu. yds. per day including the material that was handled more than once.

This is a very high cost for this work.

*Engineering-Contracting August 5, page 52.

It was obviously not possible to have done it within the contract price of 15 cts. per cu. yd. One reason for this high cost was a very inefficient foreman. He was discharged for this job. Another reason was that the contractor did not furnish long handled shovels to the men.

To cast the earth 10 ft. or more with short handled shovels was much more expensive than if long handled shovels had been used. On every job a contractor should supply himself with some long handled shovels. Then, too, instead of the men handling the earth a second and third time, there should have been only one handling, and it would have been possible to do it much cheaper with a team and a drag scraper, spreading the earth in the embankment. These things might have reduced the cost about 50 per cent.

Cost of an Earth Embankment and Gravel Facing.

The following data, taken from the August Reclamation Record, relate to the construction of the Whalen earth dike by the U. S. Reclamation Service. This dike is located at the right extremity of the Whalen concrete diversion weir and extends to the bluff of the valley. This dike, together with the concrete diversion weir abutting onto it, furnishes a means of diverting the flow of the North Platte river into the Interstate Canal, and will serve that purpose for the Fort Laramie Canal when it is constructed. The dike is about 1,600 ft. in length, 11 ft. wide on top, with an average height of 10 ft. and side slopes of $2\frac{1}{2}$ to 1.

The embankment is now practically completed and contains about 35,000 cu. yds. of earth. The earth for its construction has been taken from a borrow pit on the upstream side thereof, the nearer edge of the borrow pit being not less than 100 ft. and the outside edge at about 500 ft. The whole embankment is faced with a covering of gravel, the thickness on the top and downstream slope being 1 ft. and that on the upstream slope 2 ft. Practically the entire embankment has been covered with gravel at the present time involving the placing of about 6,040 cu. yds. of gravel. The distance from the gravel pit to the south end of the dike is 1,700 ft. on a down grade of approximately 1 per cent from the pit and the total average haul is about 2,620 ft. The free haul under the specification requirements is 500 ft.

The earth body of the embankment was placed in layers varying from 6 to 12 ins. in thickness, and these layers spread by hand and thoroughly compacted by the passage of the scrapers and teams over them. The material as excavated shrank about 20 per cent through the compacting to which it was subjected in being placed in the embankment.

The gravel facing was loaded with wheel scrapers through a trap into four-horse wagons with slat bottoms, each holding about $2\frac{1}{2}$ cu. yds. The gravel was dumped from the wagons onto the embankment, and spread on the slopes thereof by means of a Fresno scraper and a hand shovel. Foremen were paid from 35 cts. to 40 cts. an hour; laborers from $22\frac{1}{2}$ cts. to 25 cts. an hour. The labor of horses in the earth work has been rated at 10 cts. an hour, and in the gravel work two-horse teams with drivers at from 40 cts. to 45 cts. an hour; three-horse teams with drivers, at from 50 cts. to 55 cts. an hour, and four-horse teams with drivers at from 60 cts to 65 cts. an hour.

The cost of the 35,000 cu. yds. earth body was as follows:

	Per cu. yd.	Total.
Labor	\$0.219	\$7,695
Plant depreciation	.011	400
Superintendence	.004	150
Total	\$0.234	\$8,245

The cost of the 6,040 cu. yds. of gravel facing was as follows:

	Per cu. yd.	Total.
Labor	\$0.874	\$5,281
Plant depreciation	.022	135
Superintendence	.020	120
Total	\$0.916	\$6,536

The grand total cost for these two items was as follows:

Labor	\$12,976
Plant depreciation	535
Superintendence	270
Total	\$13,781

The cost data above given include 30,000 cu. yds. of overhaul amounting to \$450, which is not separately considered.

The city of Buenos Ayres, Argentina, is considering the construction of two underground railways and on May 11 opened bids for the building and exploitation of the roads. But one bid was received and owing to the conditions imposed by the bidders this will probably be rejected, and other measures taken to secure the road. The bid received contained three alternative proposals, as follows: (1) Double line, 1.67 meters gage, tunnel faced with masonry, \$18,520,598 gold; (2) double line, gage 1.44 meters, masonry facing and cast-iron rings where necessary, \$17,520,928 gold; (3) gage 1.44 meters, masonry facing, \$16,412,045 gold.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

LETTERS TO THE EDITORS.

Standard Sizes for Drawings, Blank Forms and Specifications.

Sirs—I very much regret that my advocacy for an $8\frac{1}{2} \times 10\frac{1}{2}$ -in. size for shop drawings was so obscure that Mr. Dollar (your issue for July 22, 1908) misconstrued the same. My plea had nothing at all to do with a written description of the drawing. I only wanted drawings cut to the size $8\frac{1}{2} \times 10\frac{1}{2}$ ins., so when mailed with a letter both would be of the same size and thus be more convenient for folding, handling and filing. This for the same reason that when we use *second sheets* we make them the same size as the first sheets, a reason most obvious to the dullest. The item of waste is of so small a matter as not to be considered. In cutting paper, tracing cloth or blue print generous allowance is usually made, which more than offsets any apparent economy.

If we are to have a standard size, let us have one that has been in use for many years and not advocate another.

Yours truly,

EMILE LOW, M. Am. Soc. C. E.
606 Ashland avenue, Buffalo, N. Y.

Standard Size for Periodicals.

Sirs: Allow me to congratulate you on the varied opinions you have brought out on the question of filing. There is one point on which there have been some things printed, but the principal point not touched. The various forms of sectional bookcases are those most in use at this time, and no maker with which I am acquainted makes a section which will hold the bound volumes of the *Engineering News* and *Engineering Record*. I have been compelled to have a special section built, and friends have had sections altered to accommodate these publications. It would greatly help the subscribers to these and other journals of similar size if they would adopt the same size as ENGINEERING-CONTRACTING.

Yours truly,

A. M. VAN AUKEN,
Resident Engineer,
Port Arthur, Shreveport & Memphis Ry.
Pine Bluff, Ark., July 24, 1908.

The Louisiana Law Licensing Engineers.

Sirs: In your issue of July 29th is an editorial entitled "Certificated Engineers in Louisiana," in which you poke a good deal of fun at the new law in that state. In my opinion you take the wrong view of the matter. When your boy came out of college and proudly showed you his diploma and pointed out that nicely engraved "Civil

Engineer," you knew that he was not a Civil Engineer, but you did know that he was the "makin's" and was justly proud of the boy. I believe that this attempt in Louisiana should be looked at in the same way. It will be very little work to add an amendment to the law at the next session of the legislature and then keep on adding until a good law is finally on the books.

As to the present benefit of the law. I believe that good results will come immediately from it. I am judging that Louisiana is practically in the same condition that Missouri, Kansas, Iowa and Nebraska are in. I can take you through these four states and show you county surveyor after county surveyor that would stop on arithmetic, and to whom geometry is as sealed as the secrets of Greek. I can show you where a piece of work, the estimated cost of which is \$275,000, has been put into the hands of a good honest farmer, that the law says "shall be a competent engineer." He says he is as competent as the county surveyor, and his neighbors all say the same, and I don't doubt it. I can show you a man holding the office of county surveyor in a county that spends from \$50,000 to \$75,000 a year on roads and bridges, whose only qualification was that he could run out the straightest corn-row of any man in the county. He is now practicing engineering. Of course, Jones pays the freight, but Jones doesn't realize it. Not yet, but soon. So, instead of discouraging the law, let every engineer and contractor too, get behind Louisiana and push her along.

Yours respectfully,

W. B. HAZEN.

St. Joseph, Mo., Aug. 4th, 1908.

[Comment on this letter will be found in our editorial columns. Editors].

The passenger engines on the Ferrocarril Mexicano, on the division from Veracruz to Orizaba, have been converted into oil-burning engines, the fuel oil being supplied by the extensive works at Minatitlan, state of Veracruz. Several large storage tanks have been erected on the outskirts of this city.

The National Railway Lines of Mexico has placed in order for 20,000 tons of new steel rails with a Monterey, Mexico, steel company. The price paid is said to be 60 or 65 pesos Mexican (from \$30 to \$32.50 U. S. gold). On Aug. 16 the change in the Mexican tariff on steel and iron goes into effect, and the increase in duties on steel is said to have influenced the placing of the order with a Mexican firm.

Methods and Costs; Some Old; Some New.

Special Types of Roads.—The accompanying sketches show special types of state road in Massachusetts that are constructed where a railway track occupies

way in the brick and will not crack the pavement. The Knoxville, Tenn., street railway has two miles of double track laid with 70-lb. Tee rails, a special brick with the corner hollowed off so as to fit under the rail being used. These brick come in half and whole lengths, which

Regarding this mix, 1-6-10, Mr. Saunders states that while it may not be theoretically proper, it is certainly doing the work as it is carrying a traffic which necessitates a 2-minute schedule all day long. Mr. Saunders also ascertained these facts:

One bag of Iroquois Portland cement weighs 100 lbs.

One bag of sand, not absolutely dry, weighs 103½ lbs.

One bag of screened crushed sand-stone, weighs 101½ lbs.

One bag of water, 2½ pails, weighs 50 lbs.

Two bags—1 barrow—15 shovelfuls.

5 yds. of stone using 13 sacks of cement, concreted 46.5 lin. ft. of single track.

Stadia Rod and Granite Monuments.—

In the recent resurvey of the Massachusetts-Connecticut State Line, described by Mr. Henry R. Buck, before the Connecticut Society of Civil Engineer, all tape measurements were checked by stadia, and the fences,

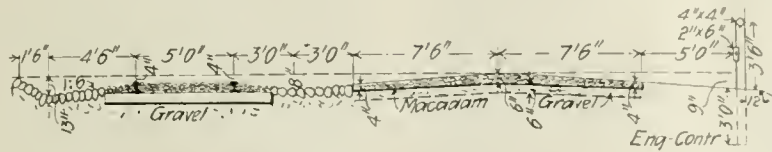


Fig. 1—Special Type Having Loose Macadam Ballast Over Railroad Ties.

part of the road. Fig. 1 shows a special type of road having loose macadam ballast over railroad ties. The track ballast is from top of ties to rail, loose mac-

are placed alternately. About every 7 or 8 ft. an expansion joint of pitch is put in, the remainder being cemented. This construction leaves a small groove

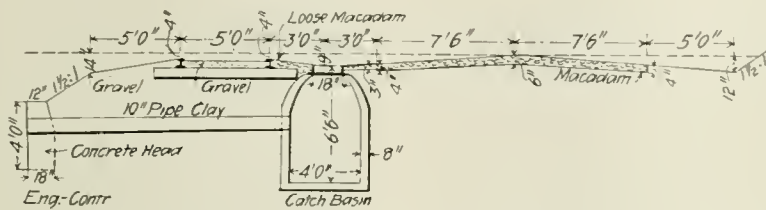


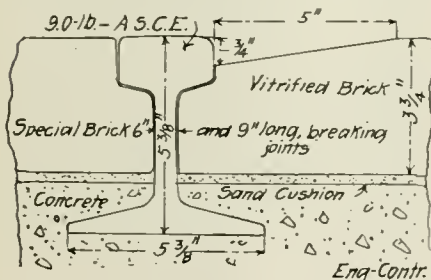
Fig. 2—Special Type Showing Drainage for Railroad on Flat Grades.

adam, varying from 1¼ ins. to 2½ ins. covered with about 1 in. of ½-in. to 1¼-in. size being used. Gutters are used on steep grades with this type. Fig. 2 shows a special type and the method of drainage for railroad on flat grades. The catch basins are either brick or concrete or a combination of both, and are spaced according to the discretion of the engineer. The distance apart is from 300 ft. to 1,000 ft., depending on the grade of the road. For the above information and the sketches we are indebted to D. H. Winslow, Resident Engineer, Massachusetts Highway Commission.

Tee Rails and Special Paving Brick.—The Kingston Consolidated R. R. Co. of Kingston, N. Y., is using a 90-lb. Tee

sufficiently large for the wheel flanges. It is all cemented together, and when taken up is like a solid mass. A ½ in. or ¾ in. sand cushion is used.

Data on Concreting a Street Railway Track.—Mr. A. W. Saunders, C. E., has furnished us the following data on concrete work done in a large city in Ohio, the data being the average of a season's work: The gang consisted of 18 men. I man looked after the water and cement; 5 men on the barrows, wheeling the aggregate; 8 men on the board, mixing and placing; 4 men tamping under the track and ties. The ties were 7 ft. 6 in. x 5 in. x 5 in. spaced 2 ft. centers. Concrete was placed 3 ins. under the ties and level with the tops in between. The excavation was 7 ft. 6 ins. wide. The manner of procedure was as follows: The iron mixing board, 8 ft. x 10 ft., was placed on the track. Eight men "mounted the board" and 5 men manned the barrows. The water man saw to it that hose was attached to hydrant and the barrel and pails were full and in place, with cement nearby. The mixture was 1 part Portland cement, 6 parts sand and 10 parts crushed stone. The sand was wheeled on the board and spread, the cement then being mixed in dry, then wetted and mixed. Next the stone is wheeled on and mixed, the water man applying the water as needed by hose or pail. The barrow men using 16 wheelbarrows then filled their barrows with the sand and stone ready for the next batch. As the men threw the cement into the track the tamperers tamped it under the rail and ties. These 18 men did 180 ft. of single track in a day of 10 hours.



Tee Rail Construction at Kingston.

rail for its track on several streets of Kingston. A special form of brick is used outside the rail as well as inside, as is shown in the accompanying cut. It will be noted that on the inside the brick goes up on the head of the rail to such a distance as to barely give room enough for the wheel flange. In the event of heavier flanges being used, experience has shown that they will cut their own

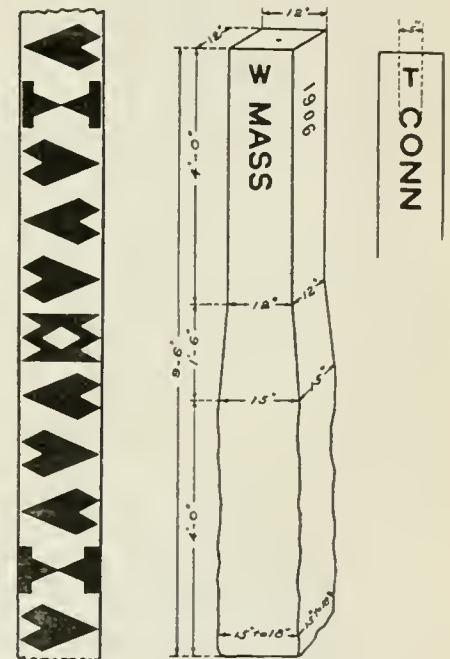


Fig. 1.

Fig. 2.

streams, roads, and buildings were located in the same way for a distance of some 300 ft. each side of the line. The stadia readings usually agreed with the tape within 1 to 3 ft. on shots 300 to 1,000 ft. long. Readings were taken only to feet, a 13 ft. rod with special markings (see Fig. 1) being used. This rod is easy to read and can be read very fast, as there are four black spots to the foot instead of five as in the common design. Single feet are read by taking the fifth part of a division. New granite monuments (see Fig. 2) were set at every road and railroad crossing the line. The stones were 9 to 10 ft. long, dressed 12 ins. square for the first 4 ft., which projects above the ground.

Road Making in Relation to Street Cleaning.*

The question of road making in relation to street cleaning is not a new one; it exercised the minds of the road makers in the old coaching days, but it has been recently accentuated by motor driven vehicles. The amount of dust which follows the track of all motor cars appears to be almost directly proportionate to the speed at which the car travels, and also in some measure to the build of the car.

The principal reasons for the excessive dust appear to arise from:

(1) The great speed at which these vehicles are driven.

(2) The draught under the car, especially where the body is low, thus forcing the dust through a sort of funnel.

(3) The sucking action of the pneumatic tires on the surface of the road.

(4) The centrifugal force of the periphery of the wheels tending to throw particles of dust a considerable distance.

If the surface of the road was absolutely clean and free from dust the evil would be cured; in other words, how should the road be constructed so as to prevent this nuisance, or how can it be kept cleaned so that there shall be no dust?

First, let us consider where the dust comes from, and I think the following are the chief factors:

(1) The disintegration of the materials with which the surface of the road is constructed, by the traffic and by climatic influences. The amount of this depends largely on the class of materials used.

(2) Imported dirt or mud from other roads, from the wind blowing it from the fields in the country and from yards and other places in towns.

(3) Animal droppings, which are considerable both in towns and in the country.

(4) The "spewing up" of the earth foundation in the case of improperly constructed roads.

It is evident that Nos. 1 and 4 could be greatly mitigated by proper construction of roads, but that Nos. 2 and 3 cannot be prevented, but that the cure consists in frequent cleaning or some method for "laying the dust." This cleaning can be rendered more easy and economical by a smooth and impervious road surface.

Laying the dust by watering is, of course, only a temporary remedy, the dirt if not removed quickly returns to dust when dry.

It has also been questioned whether the addition of water to the organic matter contained in the dust does not eventually render it more "germ laden."

So called "macadam" roads are the worst "dirt" manufacturers, under Nos. 1 and 4, of the reasons for dust which I have given. They are dependent upon (1) the quality of the stone used, (2) the nature and quantity of the binding material, (3) the contour

*From a paper by H. Percy Boulnois, M. Inst. C. E., read at the annual meeting in London of the Institute of Street Cleaning Superintendents.

and gradient of the surface (pits and "slack" places are provocative of mud and dust), and (4) unless the "bottoming" or foundation is properly made with hand-pitched stones, the "spewing up" I have mentioned is likely to take place.

Such roads also are difficult to properly clean, and, in addition, the action of either scraping or brushing is apt to disturb the surface, and "the remedy may sometimes be worse than the disease."

Unfortunately the majority of the roads in this country (except in the towns) are "macadamized"; that is, they are merely stones of various description (often local stones of a soft, pliable character), broken "more or less" to an even 2-in. gage, laid at various thicknesses on the "virgin soil," the stones "blinded" (as it is called) with very often improper materials, and either allowed to consolidate under the traffic or rolled without much consideration as to whether the crown or haunches are to be first rolled, and often without much consideration as to any scientific contour.

It is not to be wondered at that such roads have caused the "dust outcry," and that various remedies have been tried within recent years to effect some cure.

Some of these remedies have been merely palliative and required frequent and repeated applications, such as westrumite, pine oiline, dustroyd, akonia, and other patent preparations of which we do not hear quite so much as formerly; of these, however, akonia seems to hold its own fairly well, and some of the roads in Regent's Park, London, have been. I understand, very successfully treated with this preparation for some three or four years past.

Such treatment of the road surface undoubtedly lays the dust and also makes the surface easier to clean. Unfortunately, however, the uncertainty of our climate makes it difficult to insure success, as dry weather is very important during the operations of spreading these dust palliatives.

They are, however, very useful for treating roads on such occasions as race meetings, agricultural shows or other fetes, where dustless roads are temporarily required.

In the United States petroleum oil has been used, but I do not think the inhabitants of this country would stand the smell.

Preparations of tar, specially prepared so as to be thoroughly viscous, have recently been used in this country and abroad with fairly good results.

The tar can be applied to the surface of existing macadamized roads, either by hand or by one of the several tar-spraying machines now on the market. The limits of this paper would not allow me to describe in detail the methods that are adopted for the application of the tar, but in order to get any beneficial and lasting effect the following points, among others, require special attention:

(1) The surface of the road must be brought to a proper and even contour, and

be thoroughly swept and brushed before the tar is applied.

(2) The weather must be dry during the operations and immediately after.

(3) The tar must be in a sufficiently viscous condition and applied at a temperature of about 20° F.

(4) The tar must be carefully and evenly spread over the surface of the road.

(5) The tar should, if possible, penetrate into the interstices of the road metal to at least a depth of 1 in.

The lasting effect of the process seems to depend on the skill and care of the operation, the weather, and the amount and character of traffic—at present we have not sufficient evidence to say whether "the game is worth the candle." As to the cleaning of such a surface, there can be no doubt that it could be effected much more easily, expeditiously, and economically than the ordinary macadam surface.

In some quarters it is believed that by the adoption of some such process to our roads the necessity for watering and cleaning will cease, or be so lessened that a considerable saving will be effected. Personally I am a little doubtful as to this, for although the causes for dust under Nos. 1 and 4 of my statement would be minimized, there would only be a partial cure for No. 2 even if all the roads in a district were so treated, and there would be no cure for No. 3.

Undoubtedly the cleaning could be more easily and economically effected owing to the smooth surface and the necessity for frequent watering being minimized; but my personal experience of such a road surface is that the dust therefrom is of a more disagreeable character than that from a macadamized or graveled road, the reason apparently being that on an impervious surface the organic matter has no chance of being absorbed into the interstices, as is the case in a macadamized or graveled road, and that consequently even more cleaning on hygienic grounds is necessary, and so long as horses and other animals use our roads, so long will cleaning be necessary, if the dust nuisance is to be stopped.

A more permanent method for dealing with macadamized roads has been the introduction of tarmacadam, tarmac and the Gladwell and other systems, in which preparations of tar are universally used as a matrix for the broken stone. You are probably familiar with the construction of such roads, which aim at making a more lasting, impervious and smooth surface to a road.

There can be no doubt as to the hygienic value of such a surface to streets where dwellings abut thereon. As an instance of this, the medical officer of health of Battersea, in a recent report, points out that some fifty streets were made up with slag tarmacadam, and that by reason of this impervious pavement in side streets where epidemic diarrhoea had been prevalent in previous summers it had been greatly reduced by the introduction of this class of pavement, and says "of the utility of this

procedure as a factor in the prevention of infection, I am thoroughly convinced, and all sanitarians are agreed, that the impervious paving of streets is a factor of considerable importance in this respect."

No doubt the paving of these streets with an impervious surface has been the means of preventing pools of stagnant water, the soakage of moisture into the subsoil, and last, but not least, the greater facility afforded for the proper cleaning of the surface, and these taken together have improved the health of the neighborhood.

No pavement can be worse, from a cleaning point of view, than the old-fashioned "cobble," or round stone paving with open joints, now happily disappearing. Little better is "chip" pavement with open joints laid on a cinder bed, still used in some of the northern and midland towns on the plea of "economy."

Properly paved streets with granite or other hard stone setts grouted with a bituminous mixture on a concrete foundation, are better than "cobble" or "chips" or "random" pavements, and are necessary where there is heavy and continuous traffic, and when properly laid such a pavement is not difficult to cleanse.

Wood-block paving, if properly executed with first-class blocks and impervious joints, or better still with no joints, presents a surface that is easily cleaned, but with continuous traffic the wood disintegrates and forms dust. It is often a matter of some surprise to me to see the quantity of mud that is formed on a wood-paved street, though this is much less noticeable in streets paved with Australian hardwood, where the blocks have been properly laid. It is to be regretted that many of the failures of the hardwood pavements, especially in London, appear to be due to some want of knowledge in the proper laying of the blocks or of the foundation.

One of the most modern developments of wood paving, and one which represents a perfectly impervious surface, equal almost to asphalt, without the serious disadvantage of slipperiness, is a pavement known as "Acme-Sectional Hard Wood Paving Block." This is a block built up of small blocks 1 in. to 2 ins. in width, and about 3 ins. deep, held together by strips of similar wood, dovetailed into them on the underside, thus making a "sectional block" about 9 ins. long by 3 ins. wide, and about 3 ins. deep. The made-up blocks are laid on a concrete foundation in the usual manner, but the joints are most carefully grouted with a special bituminous mixture which does not crack, and is perfectly impervious to moisture. This is a most important factor in all such pavements, and I venture to think that the question of a thoroughly impervious but elastic joint for pavements has not received the consideration which it should.

The advantages of such a pavement as the Acme block are obvious. The small scantling of the blocks renders them easily seasoned. It gives plenty of joints for

"foothold," thus preventing slipping. Shrinkage and swelling are less likely to take place, as water is excluded, and no movement of the block can take place, the cause of so many failures in wood pavements. The blocks can be of less depth, only 3 ins. instead of 5 ins., or even 6 ins., with the ordinary blocks, and if there is any wear owing to a piece of inferior wood being accidentally used, the sectional area is so small that a worn block is scarcely noticeable.

Examples of this paving may be seen in Praed St., close to Paddington station; High Road, Kilburn; Finchley Road, near the Swiss Cottage, and in Borough High St. and Old St. This pavement should be an easy pavement to cleanse, and has ad-

ly regarded as a secondary consideration.

Proper cleaning, however, is not only a "luxury" to prevent the dust nuisance, but is also a "necessity" to prolong the life of the road. A neglected road is less likely to last than one which is properly "swept and garnished." I have said nothing as to the cost of cleaning—a very important question from the ratepayers' point of view—but neglect of proper cleaning is not economical from a road maintenance point of view, nor from the commercial point of view. Traction is more economical on a well-kept surface, and nothing strikes a visitor to a town more than the appearance of the streets.

In conclusion, I think the ideal road in connection with cleaning should, as much



Grab Bucket Operated by a Single Line.

vantages over asphalt which should be an ideal pavement to cleanse except for our climate, which on occasions renders the surface very slippery and greasy with a sort of adhesive and sticky mud, very difficult to dislodge except by a thorough washing and scrubbing.

I have endeavored in this short paper to give you a general sketch of "Road Making in Relation to Street Cleaning." I have been obliged to treat the subject, in a measure, from other points of view, as a road is primarily constructed for the purpose of carrying the traffic, and the cleaning of the surface is, I am afraid, general-

as possible, comply with the following requirements: The surface should be impervious, without hollows, pits or open joints. The contour should be such that a machine broom can come into contact with the whole of the surface, but at the same time water should easily run off into the channels. The roadway should not be unnecessarily wide, or the labor in cleaning and consequent cost will be increased. The surface of the roadway should be kept in good repair, and any trenches or other disturbances quickly put right. If the road maker and the road cleaner will go hand in hand, the labors of both will be lightened.

A Grab Bucket Operated by a Single Line.

Contractors handling crushed stone, sand, coal or similar materials, and who have not special grab bucket machinery for handling it by means of the ordinary two-line grab buckets, will be interested in the single line grab bucket, shown by the illustration on the preceding page.

This bucket can be used on the ordinary single drum machine.

The illustration shows the bucket as it is used. It will be noted that the derrick or crane hook is simply hooked into the bucket rope, the bucket then being ready for use. The bucket shown has been in use four years and has handled as much as 600 tons of crushed stone in 10 hours at a cost of 8/10 cts. per ton. It takes but a minute to put the bucket on or take it off.

The bucket illustrated is at the Windermere storage yards of The Cleveland Electric Railway, Cleveland. At this point the derrick is used in a great variety of service, such as the handling of rails, ties, etc., as well as with the grab bucket. It is essential, therefore, that quick changes from bucket to hook and vice versa, be made.

The bucket is made by the Brown Hoisting Machinery Co., of Cleveland, O.

The following is a comparative statement of labor forces for April, May and June in the Isthmian Canal work, the figures showing the number actually at work on the last day of each month:

	June.	May.	April.
Europeans	4,913	4,962	5,366
West Indians	16,078	16,074	15,802

Governor Harris of Ohio will soon ask the governors of Kentucky, Indiana, West Virginia and Pennsylvania to join him in appointing a joint commission to take up the matter of preventing the pollution of the Ohio River by city sewage. The legislature of Ohio provided \$1,000 last winter for this purpose.

The Turkish government has authorized the Bagdad Railway Co. to proceed with the building of the Eregli-Elif extension. There will be four sections, covering in all 525 miles. The first and second sections of the 525 miles of track will offer the greatest difficulties in construction. For instance, through the Taurus mountains, up to Adana, there will be at least 56 miles of tunnels, viaducts and bridges. From Adana the line will run through the Djihoun valley up to the Amanus and Ghaiour-Dagh ranges, which will call for another 25 miles of similar works. It is estimated that the 81 miles of tunnels, viaducts and bridges will average from \$155,000 to \$185,000 per mile. This heavy expense will be compensated by the relatively low cost of the level parts. The building of these four sections must be done in seven years. The cost of the 525 miles of railway will amount to about \$45,000,000.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0848. **Trucks.**—The Fairbanks Co., New York.

This 192-page catalog is devoted to describing and illustrating trucks, carts, cars, and barrows of all description and for many purposes. Many of these tools are made especially for contractors, who will find this catalog a useful reference book. The catalog has a good index.

No. 0849. **Spiral Riveted Pipe.**—American Spiral Pipe Works, Chicago, Ill.

This pamphlet, No. 22, contains 16 pages and shows the many uses to which this pipe has been put. The various accessories as joints, flanges, elbows, etc., are illustrated, and a striking photo shows the great strength of this pipe. An interesting pamphlet.

No. 0850. **Hoisting Engines.**—The Hendrie & Bolthoff Mfg. and Supply Co., Denver, Colo.

A 64-page catalog devoted to the hoist question. The hoisting engines shown are both steam and electric and are for heavy service for contractors and mining purposes. Each machine is illustrated, and a written description accompanies the cut.

No. 0851. **Rock Crushers.**—Traylor Engineering Co., Trinity Place, New York.

This company manufactures three styles of rock and ore crushers, the gyratory, the Blake crusher and the Dodge crusher. These crushers are illustrated in their general catalog H, in which is also listed other machinery used in crushing and rolling rock and ore, and conveying devices, as elevators, sand pumps, belt conveyors, and cars.

No. 0852. **Continuous Roller Presses.**—Kutztown Foundry and Machine Co., Kutztown, Pa.

A nicely gotten up 24-page catalog, describing and illustrating roller presses for garbage reduction. This system of pressing garbage was applied at the suggestion of the late Col. George E. Waring. The catalog shows the machines in operation, and has drawings showing their operation. This catalog should be in the hands of every engineer interested in garbage disposal.

No. 0853. **Reinforced Concrete.**—Turner Construction Co., 11 Broadway, New York.

This 8-page bulletin, No. 4, issued bi-monthly by this company, describes a recently erected warehouse and factory building in Jersey City. The advantages of concrete for a structure of this character are set forth.

No. 0854. **Hoisting Machinery.**—Traylor Engineering Co., Trinity Place, New York.

A 72-page catalog in which are listed various hoisting machinery, as hoisting engines, cages, cars and skips, engines and boilers, and buckets. These machines are for the use of contractors and miners.

No. 0855. **Boilers.**—Traylor Engineering Co., Trinity Place, New York.

Describes the Hawkes boiler made by this company. These are horizontal boilers for heavy service and permanent work. They are set up with brick masonry or with steel jackets. This is a 20-page catalog.

Personals.

Mr. D. A. Stivers has been elected City Engineer of Independence, Kan.

First Lieutenant Charles Leeds, Corps of Engineers, U. S. Army, has been relieved from station at Los Angeles and will take station at Pasadena, Cal.

Mr. R. J. Newell has resigned his position as Assistant Engineer of the U. S. Reclamation Service to take a position in private employ with the Great Shoshone & Twin Falls

Water Power Co. Mr. Newell entered the Reclamation Service during May, 1903, and has been employed throughout his service on the Mindoka and Payette-Rolse projects.

Major James B. Cavanaugh, Corps of Engineers, U. S. Army, has been detailed as a member of the Lighthouse Board, vice Lieut.-Col. Harry F. Hodges, Corps of Engineers, relieved.

Mr. T. Brooke White, Assistant Engineer, after a number of years of service in the Washington office of the U. S. Reclamation Service, has been transferred to the Office of the Supervising Engineer, Portland, Ore.

Col. William H. Bixby, Corps of Engineers, U. S. Army, has been detailed as engineer of the Fifteenth Lighthouse District, to relieve Capt. Gustave R. Lukesh, Corps of Engineers, on Oct. 1.

The Board of Aldermen of New York City have increased the salary of Mr. Charles F. Lacombe, Chief Engineer of Light and Power in the Department of Water Supply, Gas and Electricity, from \$5,000 to \$7,500.

Mr. D. C. Fenstermaker has resigned as Chief Engineer of the Louisiana Railway & Navigation Co., and the office has been abolished. The duties formerly under the Chief Engineer's office will be assumed by the General Roadmaster, Mr. C. R. Mee, and his office moved to Shreveport, La.

Mr. Will M. Dixon, M. Am. Ins. E. E., and Mr. Howard F. Smith, Mechanical Engineer of the Louisiana Purchase Exposition, have entered into a partnership under the firm name of Dixon & Smith, Engineers, and will conduct a general engineering business, with offices in the Wright Bldg., St. Louis, Mo.

Messrs. James K. Lyons, M. Am. Soc. C. E., and James B. Hardie, both long associated with the industrial interests of Pittsburgh, Pa., have become associated with the Gas Power Engineering Corporation as President and Vice-president respectively. The company has established offices in the Empire Bldg., Pittsburgh.

Major E. Eveleth Winslow, Corps of Engineers, U. S. Army, has been detailed as Assistant to the Engineer of the Twelfth Lighthouse District, to take effect upon his arrival at Honolulu, to relieve Capt. Curtis W. Otwell, Corps of Engineers. Major Winslow will report to the Engineer of the Twelfth Lighthouse District.

Mr. R. D. Tyler, Assoc. M. Am. Soc. C. E., has resigned his position as Division Engineer of the Franklin & Clearfield R. R. (New York Central Lines), and has allied his interests with the Bernard Crockery Co. of 1544 Blake St., Denver, Colo. Mr. Tyler had been in the employ of the New York Central Lines on construction work since January, 1902.

Mr. George Fred Hayes has been appointed Director of Publicity for the Chicago Concrete Machinery Co. of Chicago. Mr. Hayes is eminently well fitted for this work, having had previous experience in the advertising departments of Stromberg-Carlson Telephone Mfg. Co., Kenfield Publishing Co., The Wilson Co., and the E. H. Baumgartner publications.

The Committee on Engineering of the Pittsburgh Chamber of Commerce, appointed to consider means for preventing flood losses in Pittsburgh and vicinity, has elected E. K. Morse, chairman; Emil Ewensson, vice-chairman, and George Lehman, secretary. The other members of the committee are William G. Wilkins, Julian Kennedy, Morris Knowles, A. B. Shepherd, Maj. H. C. Newcomer, Paul C. Didier and S. C. Long.

Dr. Howard M. Woodhead and Dr. Milo M. Quaife of the University of Chicago have been selected by the City Council Committee on Local Transportation of Chicago, Ill., to obtain for the city information regarding the manner in which the subway systems of European cities and the United States are being operated. Dr. Woodhead will go to London and Paris at once, while Dr. Quaife will visit New York, Philadelphia and Boston.

The following changes in the stations and duties of officers of the Corps of Engineers, U. S. Army, have been ordered. First Lieutenant Arthur Williams is relieved from duty under the orders of Lieut.-Col. James G. Warren, to take effect upon his return to his station after the completion of his duties pertaining to the national match at Camp Perry, and will proceed to Denver for duty as chief engineer officer of that department, to relieve Major Robert R. Raymond. Lieutenant Williams will proceed to Washington Barracks for duty with the engineer troops stationed there and to the commandant of the Engineer School for duty as an instructor at the school. Capt. Peek will proceed to Fort Leavenworth for duty with the Third Battalion of Engineers.

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**Concrete Building Construction of
Separately Molded Numbers.**

Concrete building construction by casting the members separately and erecting them in place after they have become hard enough to be handled safely, has recently secured many admirers in America. As engineers see the announcement one after another of new inventions of cast concrete beams, columns, slabs, etc., they are inevitably urged to a comparison of the new construction with the more familiar monolithic concrete construction so widely used. What are the advantages of constructing buildings of beams, columns, slabs, etc., separately cast or molded in factories or yards as compared with molding the various members in place in the building?

In general support of the advantages of building construction of separately molded members we print in another column a paper by Mr. Charles D. Watson, the working manager of a firm which has developed a very elaborately worked out system for constructing buildings of factory made concrete members. Practically all the claims to be made for the method seem to have been made in this paper. One of the advantages claimed is less cost.

It may be asserted, we think, that this very important matter of comparative cost must for the present be considered undetermined. We have published in these columns a great many costs of monolithic buildings. Costs of concrete buildings of separately molded members are very rare, but we have presented such as have been obtainable. In no case has it been possible to compare without a great many arbitrary assumptions, two buildings of similar type and character one built of concrete molded in place, and one of separately molded concrete members. In a word, we have as yet no indisputable documentary evidence that building construction of separately molded concrete members is either more costly or less costly than monolithic construction. We can, however, point to indicative evidence.

The kiln house of the Edison Portland Cement Co., a one-story building, consisting of bracketed columns carrying heavy roof girders, spanned between with slabs, cost as follows, per cubic yard of concrete:

Items.	Per Cu. Yd.
Columns in place.....	\$15.13
Girders in place.....	16.57
Roof slabs in place	9.06

In this building the columns, girders and slabs were molded separately and erected like corresponding steel members. The plant for erection was available and of very high character, and the builders used their own cement and stone which they charged up at \$1 per barrel, and 60 cts. per cubic yard, respectively.

On their face, at least, these figures do not show any saving in cost over monolithic construction of similar character.

For example, a one-story car barn, described in our issue of Oct. 23, 1907, cost for concrete in place, \$9.06 per cu. yd.; the floors and columns of a six-story building, described in our issue of Oct. 9, 1907, cost \$12.65 per cu. yd. of concrete in place; a two-story factory building, described in our issue of April 29, 1908, cost \$19.87 per cu. yd. of concrete in place.

We might readily present a more detailed comparative analysis than the above, but the gain would not be great. The point we wish to bring out is that so far as the figures now at hand permit one to conclude, there is no overwhelming evidence that building construction of separately molded members offers any economy in cost over monolithic building construction. In making this statement we hold no brief for monolithic construction; we merely insist that in so far as this particular of cost is concerned, the advocates of construction with separately molded members "must show us" that they possess an advantage. We will gladly give space to any reliable figures in proof of the cost of either type of construction that may come to us.

Specifications for Embankments.

Specifications for any work should be definite and clear and especially so for embankments, as provisions regarding earth banks affect the cost of the work considerably. The exclusion of stones, the compacting and how it shall be done, the class of material acceptable, and many other conditions affect the cost.

We copy the following clause from a specification on embankments for a railroad:

"Embankments about masonry shall be built at such time and in such manner and of such material as the engineer may direct."

The fact that this clause appears in the specifications means that some special work is to be done on embankments about masonry, but what the character of the work is to be no one knows but the engineer. Nothing could be more indefinite.

Any contractor bidding on the work after this clause cannot help being in a quandary. He may have to borrow special material to place around a culvert, as the writer once had to do under a similar specification. In that case the embankment had already been made around and over an arch culvert, from material from a cut which was a disintegrated rock, when the chief engineer made a trip over the line and refused to allow this material to remain in the bank. He ordered it taken out and wasted, and a material borrowed down stream below the culvert and hauled by a long road to the top of the embankment, which was a 20-ft. fill. All this extra work had to be done at the contractor's expense. But little attention had been paid to this clause in bidding on the work, much to the contractor's subsequent regret.

Even if the contractor is conversant with the plans of the engineer who wrote the specification, he may still be made to undergo hardship under such a clause, as the engineer doing the work may want other things done than those in the mind of the man who drew up the specifications. In every case it is the contractor who suffers.

There is no excuse for such a clause. Every detail of the work should be specified, and then not only will all the embankments around masonry on the road be built in the same manner and of suitable material, but the contractor will know what is expected of him before bidding on the work.

In such specifications an important item to mention is the time that must elapse from the finishing of the masonry until material can be deposited around it and over it. One of the editor of this journal was once compelled to keep an outfit idle nearly 60 days, waiting for permission to fill over a large arch, because the engineer had the right to name the time to allow the arch to set, and, as he expressed it, he was not taking chances. Meantime the contractor's mules were eating but not working.

The elimination of such clauses as the one quoted above from specifications will be part of the work mapped out for the new American Society of Engineering Contractors. Notice of the formation of this society has appeared in the columns of this paper from time to time. About 1,000 engineers and contractors have already made application for membership. A blank for this purpose will be found on one of the advertising pages. Every civil engineer and contractor engaged in construction work should be a member of this new society.

The Russian Duma has approved an estimate of \$64,500,000, or about \$16,000 per mile, for double tracking the Siberian Railroad.

A bill is to be introduced at the next session of Congress providing for an appropriation of \$7,000,000 for the construction of a highway from the city of Washington, D. C., to the Battlefield of Gettysburg in Pennsylvania. As proposed the road will be over 100 miles long and 150 ft. wide.

The University of Colorado will soon have a completely equipped timber testing laboratory at Boulder, Colo. Two testing machines will be installed, the larger one capable of exerting a pressure of 200,000 lbs., and the smaller one capable of exerting a pressure of 30,000 lbs. Both of these machines are of the latest design and each is driven by a separate motor. The first problem taken up will probably be an investigation of the relative strength of dead and fire-killed timber as compared with that of timber cut while still growing.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Factory-Made Concrete.*

BY CHARLES D. WATSON.†

The test of time has conclusively shown that Portland cement concrete, because of its durability and resistance to fire, came nearer approaching the ideal material for building purposes than any other previously known agent, when the discovery was made that in combination with iron or steel it could be used for structural purposes, thus opening a new era in building construction. Architects and engineers immediately recognized in it a long sought combination of two materials. The one, a good resistant of compressive force, and the other a great resistant of tensile force which, when combined, not only acted in unison on account of the adhesion of the cement to the steel, but having practically the same coefficients of expansion, were not subject to the usual defects of composite construction.

When after considerable demonstration and test it was shown that the concrete not only preserved the steel from corrosion (eliminating one of its greatest defects) but apparently increased its power of resistance to stress, it is little wonder that this generation has witnessed in reinforced concrete construction what appears to be the beginning of a revolution in building methods. The engineering profession is to be congratulated upon the enormous progress made in the investigation and application of this new material, the demand for which has been so great that it has been about all, and in some cases more than they could do to keep investigation and research abreast with actual construction.

Thus far, for structural purposes, the tendency has been confined almost entirely to what is known as monolithic construction, that is where the building is supposed to be a single mass or unit. Now that this form of construction has finally reached a stage where it may almost be called an exact science, the progressive engineers are beginning to realize that they are so handicapped in design and application due to the excessive cost of forms for erecting under present methods, and to the difficulty of getting reliable field-made concrete, necessitating the use of such large factors of safety, and the danger due to premature striking of forms, that not a few are beginning to question

whether we are working on the right lines by the present methods of manipulating this material. The science of the manufacture of steel has reached a point where the designer can depend upon certain strength within reasonable limits, but not so with the manufacture of concrete. Not only does it vary with the quality and amount of cement used, but when made in the field, with practically every other condition with which the engineer has to contend, such as age, temperature, amount of water, quality and size of aggregate and character of mixture. Therefore we can hardly contend that reinforced concrete is ideal, because of its being a combination of steel, which is a material of high tensile strength, with concrete, a material of high compressive strength, when the latter may or may not be a material of such strength depending entirely upon the condition under which it is made.

The majority of designers take as working loads on concrete, values of not over 600 pounds per square inch for its compressive strength in cross bending. An analysis of the majority of tests made would indicate that at the time concrete is stressed, which is seldom at over thirty days of age under present methods, that the ultimate strength is not over twice this amount. While this would indicate the use of a factor of safety of only two, this, of course, is not strictly so, owing to the fact that the modulus of elasticity of concrete changes with the amount of stress, so that the actual factor of safety is greater.

However, it can be demonstrated that concrete can be made in a factory where the conditions of temperature, amount of water, the size and proportion of aggregates can be regulated which will have at least 50 per cent more initial strength than the strongest field-made concrete at the same age, and which will be more than twice as strong when first subjected to loads, owing to the additional length of time that it can be left to harden, and which has great virtue as regards design in that it has uniform strength. Under such conditions, can we justly say that we are getting full advantage of concrete as a structural material; has not the time come for us to develop the science of making concrete the same as we have developed the science of making steel so that we can take larger working units of strength? Of course, the disadvantage of using concrete with a small unit of com-

*Abstract of a paper read before The National Cement Users' Association.

†Manager, The Standard Construction Co., Pittsburg, Pa.

pressive strength can be offset by increasing the area or volume of the material used, but such an increase means an additional cost which is again enhanced by the additional dead load in the structure. Furthermore, the employment of an inferior grade of material in which several times the actual volume required must be used for the purpose of safety can hardly be considered good engineering.

Besides the difficulty of contending with a material of varying and indeterminate strength, such as field-made concrete, the designer has another and perhaps greater obstacle with which to contend under present methods; that is, the cost of forms. With the cost of forms and centering, already approximately 40 per cent of the entire cost of field reinforced concrete construction, and with lumber constantly increasing in value, it is evident that if this form of construction is going to continue to develop on a large scale some means must be employed to reduce this cost.

A careful analysis of the present conditions under which reinforced concrete is constructed cannot help but lead one to the conclusion that present methods are still crude and unscientific, and like the history of all such developments, we must abandon the use of hand-made materials, which are subject to faults due to human errors, and adopt the machine-made. If so, the final outcome must be the use of factory-made reinforced concrete. Factory-made concrete has obviously every advantage over field-made, except in the matter of continuity of members and the cost of transportation for long distances. As to continuity: with the present development toward the shop fabrication of reinforcement and rigid connections of members it is doubtful if the monolithic method of construction really has so much advantage in this particular. Certainly, more rigidity can be obtained than in a structural steel frame. Furthermore, in the majority of cases it is impossible to get a truly monolithic structure by present field methods, since the cost of placing concrete continuously makes it practically prohibitive. There are other positive disadvantages in monolithic designs due to the absence of expansion joints, the differential expansion of members of different sections and the consequent thermal stresses set up in such structures which are beyond the engineer's power to calculate.

As regards transportation of factory separately molded members there can be little doubt that in the larger centers of population the cost of transporting the finished product is overcome by the many other advantages of the factory-made members, such as: first, elimination of forms; second, concrete of much greater strength and consequently of much smaller volume to carry equal loads; third, the use of more economical sections; fourth, the economy of shop methods of han-

dling and mixing the materials; fifth, the greater speed of erection; sixth, certainty of results on account of mechanical methods of fabrication of the reinforcement and casting of members; seventh, the opportunity to test same before subjection of load; eighth, ease of alterations; ninth, absence of accidents during erection, and tenth, high-grade finish made possible by better forms.

First, as to saving of field forms: It is obvious that any system of concrete construction which will eliminate the present expense of the forms required in field work would be of the greatest advantage. The molding of concrete in this way is not only expensive, but fraught with great danger, inasmuch as the members are completely covered until the forms are removed, which obscures defects and prevents inspection.

Second, as to the quality of concrete and section of members: Recent experiments have demonstrated the enormous variation which may occur in the strength of concrete due to its quality. The profession is now giving this question of high-grade material considerable prominence. We constantly hear references to the great strength of concrete with the common expression "as hard as rock," but the real conditions under which it is used for structural purposes are such that we are compelled to use working values in compression, which are about half of what we use for soft timber. The result is one of the greatest objections to concrete construction; that is, to get sufficient strength to carry loads we are compelled to erect such massive beams and columns that our buildings become architectural monstrosities, besides being uneconomical on account of the space wasted. In entering a concrete building of considerable height and with long spans designed for heavy loads the massiveness of the beams and columns gives one the impression of clumsiness rather than stability. Development of the science is gradually eliminating this defect, but the primary reason still remains, and can only be solved by the use of a higher grade material which will have greater strength, so that a smaller section may be used.

There can be no doubt that the highest quality of concrete can be made only in a factory where every condition as to quality of material, methods of manufacture and seasoning can be carefully studied and regulated. Men expert in each division of the process of manufacture can supervise all operations, and by the use of mechanical equipments, which it is impossible to establish in the field, will be enabled to work at the highest point of efficiency and economy.

Next in importance to the quality of concrete is the advantage of economical sections into which it may be molded under shop methods. Every engineer knows that in a rectangular beam there is great waste of material as regards actual areas

under stress. For this reason steel is rolled into what are commonly known as structural shapes, but even in the manufacture of steel mechanical difficulties prevent the rolling of truly economical sections. Concrete being a plastic material presents no such difficulties, and when factory-made, practically any section can be cast in permanent metal molds by proper appliances for filling same. Also the distribution of reinforcing steel can be developed to a much higher degree and the position of the steel in the member made absolutely certain. Many attempts have been made in the field to cast concrete members of more economical shape and numerous systems have been devised, consisting mostly of the use of hollow tile or similar material for coring or reducing the sections. But under field conditions the saving is but slight, as the hollow cores must be left in the work and the whole temporarily supported until the concrete is sufficiently hardened to enable it to resist loads.

As to the economy of shop methods of manufacture over field methods this has so often been demonstrated in all lines of industry that any discussion is unnecessary. A plant for such a purpose should be located in the larger centers of population and at or near some source of supply of raw material. Facilities for handling, casting and finishing the completed products can be permanently installed; also, crushing, screening and mixing machinery that will automatically regulate the size and proportions of materials which will not only produce uniform and high quality results, but at a minimum of expense.

With a proper arrangement of plant it certainly is not unreasonable to expect that structural concrete sections can be manufactured, transported and erected in a factory, transported and erected in the field at a cost per cubic yard not much in excess of what it now costs to erect concrete building blocks, plus the cost of steel reinforcement and the fabrication of same. This in round figures should not exceed \$15.00 per cubic yard actual measurement. Bearing in mind that these factory-made sections can be made with a saving of from 33 to 50 per cent of the volume necessary to produce the same results by field methods, due to the fact already stated that the concrete is twice as strong and of more economical section, its cost would be not over \$10 per cubic yard, as compared with the actual contents of present field-made monolithic construction.

The development of the unit system of structural concrete is sure to result in a most productive field for the manufacturer of cement products and should grow into a large and important industry. The greater speed at which buildings constructed of factory-made units may be erected, the comparative ease with which alterations may be made and the absolute

certainly of results due to the fact that members can be tested are quite apparent advantages. There seems to be little doubt that the majority of failures of monolithic construction are due to the premature removal of forms. It is uneconomical to leave these forms in place more than three weeks at the most, and the strength of concrete at this age is seldom more than half of what it attains in two months. The use of factory-made materials will allow full loads to be imposed immediately after erection, and as it requires no temporary supports all danger of failures is eliminated.

From an architectural view, field-molded concrete is objectionable, not only on account of the enormous size of its members, but on account of the difficulty of getting a high-grade finish; factory-made material can be cast in smaller sections and in forms, or in sand molds, which leaves a high grade and very satisfactory finish. Members can even be designed and molded with a view of architectural appearance, combining both the structural and architectural features of the building without the expense of additional work of finishing and ornamentation.

As already stated, the only possible disadvantages that the unit system might have are those of transportation of heavy members for long distances from the factory and the absence of continuity between members.

The economics of shop manufacture and erection, combined with the fact that much less volume of concrete is required to produce the same results on account of more economical sections and higher quality of material, will more than overcome the difference in the cost of transportation.

As to the advantage of continuity of members and rigidity obtained by monolithic construction, here, without doubt, lies the real problem in the development of the unit system. However, the problem admits of ready solution by proper care and ingenuity in the fabrication of reinforcement. The members can be made with projecting connections, which can be rigidly attached to each other in the field similar to the manner in which structural steel is erected, and these connections can afterwards be fireproofed with a small amount of field concrete.

The bolting of connections can be substituted for the expense of riveting, as is required in structural steel. For buildings of few stories the combination of the adhesion of mortar and the use of projecting dowels is all that is necessary. Such construction requires slightly more steel than is ordinarily used in concrete construction, but the expense of this is more than overcome by other economies.

In cities where the cost of structural steel is not excessive it has been found that a very economical, rapid, safe and efficient mode of construction is to erect a light structural steel frame, which is de-

signed for dead load only and is afterwards fire-proofed by supporting forms on the members and filling in around them with concrete, the steel being designed just within its elastic limit, and the additional strength required to resist live load and provide for a factor of safety being supplied by the concrete. In the specifications of one designer this form of construction is referred to as reinforced steel construction. Certainly this form of construction could be made much more economical if the concrete fireproofing was put on at the factory, as it would entirely eliminate the cost of field forms and enable the designer to take advantage of the fact that the member has the additional strength of the concrete added, enabling him to reduce the amount of steel. The only additional cost of erecting reinforced steel frame of this nature over that of a regular structural steel frame designed for both dead and live load would be the additional cost of transporting and erecting the heavier members. However, recent calculations made on a four-story apartment building showed that this form of construction could be carried out using the customary loads for this style of building, and spans of sixteen feet, in which no member weighed more than one ton, the actual weight of the members being a trifle over twice what the weight would be if a structural steel frame was used and designed for both dead and live loads. The saving in forms, the greater speed of erection, the economy of design in this form of construction certainly warrants its careful consideration by the designing engineers.

Doubtless, the greatest field for factory-made unit concrete construction is for buildings of a few stories in height and for curtain walls, floors, roofs and partitions of all buildings.

This system of construction, when properly developed, should completely solve the problem of the fireproof residence. In Europe this form of construction is in considerable demand, although as far as the writer's knowledge extends, there is no plant designed for and devoted exclusively to it.

In America we have had several demonstrations of the practicability of such construction in the buildings recently erected by the Edison Portland Cement Company, and a factory building at Reading, Pa., erected a few years ago by what is known as the Vistini system. These buildings, all being constructed with material made at the site, are not complete demonstrations of the economy of such construction, for it is in the saving of labor by manufacturing in a shop, especially designed and equipped for this purpose, that the greatest economy should be effected.

Unit construction of factory-made reinforced concrete members properly seasoned and tested, in which the units are made

in the most economical size for handling and erection, and of such section, proportions and quality of material as to give the maximum efficiency of both steel and concrete, is the logical conclusion of the great development now taking place in concrete construction. It would be the repetition of the development of every other structural material, the displacement of crude, expensive and uncertain hand methods by the more positive, efficient factory methods.

As timber increases in cost, concrete is certain to come into more general use. For certain purposes it has already become more economical. As the science of the manufacture of Portland cement develops so will the science of its application and the method of concrete construction, which will eventually be adopted, will be the one in which the materials are worked to their highest point of efficiency, which, in the belief of many, can be obtained only by the unit system of factory-made economically designed members.

No doubt the reason that this form of construction is not more generally used is due to the excessive cost of equipping a plant for manufacturing. Sufficient development has already taken place, especially in Europe, and in a few instances in America, where buildings have been erected on the unit system of separately molded members made at the site, to demonstrate its practicability. The true economy of this form of construction will only be demonstrated when the system is extended to factory-made members.

A tunnel more than a mile in length said to be the longest in existence for use by municipal electric surface car lines, has just been opened for operation by the Genoa Street Railway Co. of Genoa, Italy. It connects Genoa with the adjacent large commune of Rivarolo, which previously was reached by circling the mountain, the distance being now shortened 11-3 miles, and the trip made in fifteen minutes less time. Construction work was begun on June 1, 1905.

The grand total of excavation on the Isthmian Canal during the month of July was 3,168,840 cu. yds., all of which except 122,884 cu. yds. was taken from the Canal prism. This establishes a new record for excavation in the rainy season, being 108,533 cu. yds. more than the record for June, and 311,430 cu. yds. short of the highest dry season record, that of March, 1908. Compared with July, 1907, it shows an increase of 2,105,114 cu. yds. There were 26 working days in both June and July. Of the grand total of July excavation 1,847,173 cu. yds. were taken out by steam shovels, and 1,321,667 by dredges. The average rainfall in July for the territory in which excavation is in progress was 11.14 in., as compared with 10 in. in the previous month, and with 10.13 in. in July, 1907.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Excavating Earth and Hardpan for a Creek Change, with Comments on the Method Used and Manner of Staking Out the Work.

Stream diversions and changes are always more or less difficult to make. The work to be described was the changing of the channel of a small creek in the Cumberland mountains, in connection with the construction of a new line of railroad. The located railroad crossed the creek twice within 300 ft. and to make a diversion of the stream meant the saving of a 20-ft. arch culvert.

The new channel was made 20 ft. wide on top, 15 ft. on the bottom and had an average depth of 6 ft. It was about 250 ft. long. The top 2½ ft. was a sandy clay, while the rest of the material was a hard cemented gravel. This had to be blasted before it could be shoveled.

The blasting was done with dynamite, holes being put down in the gravel in series, being spaced 5 to 6 ft. apart, and about 15 holes shot at one time, with a battery. Picks were then used to loosen the material.

Under the specification cemented gravel was classed as loose rock, and the engineers classified the excavated material as 400 cu. yds. of earth and 600 cu. yds. of loose rock, there being in all 1,000 cu. yds. of excavation. The excavated material was placed in an adjoining embankment, the earth being loaded into wheelbarrows. The haul averaged 50 ft. Boards were used as runways. When the work commenced a man loaded a wheelbarrow and pushed it to and from the dump, but, as the trench became deeper, one man staid in the trench and loaded the barrow, while another operated it. However, as two barrows were used, one being loaded while the other was going to the dump, it meant a wheelbarrow for each man.

Cost of Blasting Hardpan.—In all about 80 holes were drilled, each hole being put down to a depth of 6½ ft., making 520 ft. of drilling necessary. These holes were put down by two men with a 12-ft. churn drill, taking about 8 days to do the work. This meant 10 holes drilled per day, or about 65 ft., and, with wages at \$1.25 for 10 hrs., gave a cost for drilling of about 4 cts. per ft. It took about two days' time for these two men to dry the holes (water stood in the bottom of them) and do all the necessary blasting, thus costing about 6 cts. per hole for labor for blasting, making all the labor of drilling and blasting 4.4 cts. per ft. of hole.

About 2 lbs. of 40 per cent dynamite was used to the hole, 172 lbs. being actually used for all the holes. This meant an average of 0.28 lbs. of dynamite per cu. yd. of cemented gravel. The total cost of blasting was:

Laborers, 20 days, at \$1.25.....	\$25.00
172 lbs. dynamite, at 11½c.....	19.48
80 electrical exploders, at 4c.....	3.20

Total	\$47.68
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For the 600 cu. yds. of cemented gravel 1,000 cu. yds. of excavation, the cost per this is a cost of 8 cts. per cu. yd. for blasting, but if we distribute this cost of the cu. yd. is 4¾ cts.

Cost of Excavation.—The total cost of the work amounted to the following:

Foreman, 22 days, at \$3.....	\$66.00
Laborers, 188½ days, at \$1.25.....	235.63
Blasting	47.68

Total	\$349.31
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The average cost per cu. yd. in detail was:

Foreman	\$0.066
Labor, loosening, shoveling and wheeling	0.236
Blasting:	
Labor	0.025
Explosives	0.022

Total	\$0.349
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The cost per cu. yd. for each class of material excavated was as follows, being a comparative cost to the price paid for each class of excavation:

Earth:	
Foreman	\$0.042
Labor	0.148
Blasting:	
Labor	0.015
Explosives	0.013

Total	\$0.218
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Loose rock or hardpan:

Foreman	\$0.083
Labor	0.297
Blasting:	
Labor	0.031
Explosives	0.026

Total	\$0.437
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One man loosened, loaded and wheeled 5¼ cu. yds. per day, which is a fair day's work in this class of material and under the conditions named.

Two valuable lessons are to be learned from this job. The first is a lesson for the contractor. This excavation should never have been made by hand, but instead teams with drag scrapers should have been used.

Because they have not the proper tools for a piece of work, contractors frequently believe they can use some obsolete method or do the work by hand and save the price of the extra equipment needed. In nine cases out of ten this means a loss of money.

This creek change was made in the mountains, and the work on the railroad was mostly rock work and was done with carts and small cars. The contractor did not have any drag scrapers in his outfit and rather than buy them, he did this work with men and wheelbarrows.

A 50-ft. lead is ideal drag scraper work. Three scrapers are needed for such a lead and three No. 1 drags cost \$6.50 each. A 4 horse railroad plow capable of plowing the cemented gravel after it was blasted would cost \$24, hence the necessary tools would have cost \$43.50.

The expense of operating such a gang per day, with the wages paid and teams at \$3.50, which was the rate paid for two horses and a driver on this job, would have been as follows:

1 foreman.....	\$ 3.00
3 scrapers, at \$3.50.....	10.50
1 4 horse plow, at \$7.....	7.00
1 scraper loader.....	1.25

Total	\$18.75
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Such a crew could have easily moved 30 cu. yds. per scraper per day, or a total of 90 cu. yds. The item of blasting would have remained the same, as the railroad plow can loosen any material that can be picked. Such a crew would have finished the job in 10 days, the total cost being:

Scraper gang.....	\$206.25
Blasting	47.68

Total	\$253.93
Cost of outfit.....	43.50

Grand total.....	\$297.43
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This gives an average cost per cu. yd. for the work of about 25 cts., and when the cost of the outfit is included, not quite 30 cts. Charging the whole cost of the tools against this job, although 11 days wear would not materially effect their value, there is saved over \$50 on this job by the use of the scrapers. It was clearly a mistake on the contractor's part to have used wheelbarrows on this work.

The second lesson learned was from a mistake of the engineer. As stated, this creek change saved a 20-ft. arch culvert. Such a culvert was certainly designed to carry the flood waters of the creek, hence a channel dug 15 ft. wide on the bottom, 20 ft. wide on top and about 6 ft. deep was of such an area as to carry the flood water of the creek. The creek had a grade of about 1 per cent, and the new channel was given the same gradient. To have planned such a channel for this creek change was a waste of money.

The land value is not to be considered, as the country was undeveloped, and on new railroad construction this is generally the case. Consequently there was no need

of excavating such a wide and deep channel. The old channel should have been dammed up well, so that the water could not have affected the railroad embankment, and a ditch 8 or 10 ft. wide, just wide enough to have allowed room for working scrapers, without slopes to the sides, would have been an ample channel to have started the water through it. The upper end of the new channel should have been deep enough to have started the water through it—that is, of the same elevation as the bottom of the old stream—and the grade given to the channel should have been a level one. This would have saved about 2½ ft. of hardpan excavation in the lower end of the channel.

Such a channel would have dammed up the water in the creek at first, but the water, when it did start to flow, would have gone through the new channel, and the first heavy rain storm would have scoured out the channel to the proper grade and width. As it was, the channel made was scoured badly the first winter after it was built and the slopes and sides washed.

More than half the excavation could have been saved in this manner, the water being counted on to do the rest of the work. Such mistakes have been made frequently in railroad construction. The writer remembers an incident of this kind in the southwest. A young engineer had a stream diversion to make about half a mile long. He staked it out to conform to the size of the old stream, and had just started the contractor at work with his buck scraper when the chief engineer made his appearance. The latter showed the young engineer that it was cheaper to build a timber bridge than to make this excavation, and ordered a channel to be staked out just wide enough to work a buck scraper in it. The first rain made the channel conform somewhat to the original stakes of the young engineer.

An excuse for staking out such channels is that in creek bottoms it is often necessary to borrow material for the embankment, and two birds are killed with one stone by borrowing the earth from the stream diversion. This is an injustice to the contractor, as a rule, for such work is generally much more expensive than excavation done on the grade of the railroad, and borrow pits should be located with reference to embankments to be made. There are times, however, when the two things work to advantage, and the experienced engineer will be quick to discern such conditions.

These remarks do not apply where land is valuable, nor to changes made in streams to reclaim land. The problems for such work are entirely different.

The Chilean Government estimates for 1909 include an appropriation of about \$10,000,000 for the construction of new railroads and providing new rolling stock.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

New Methods of Laying Duct and Building Manholes for Electric Transmission Lines, With Figures and Comparative Costs.

Some changes in standard methods of laying ducts and building manholes for electric transmission lines have recently been adopted by several large companies. While many of these changes are comparatively slight, still they are changes

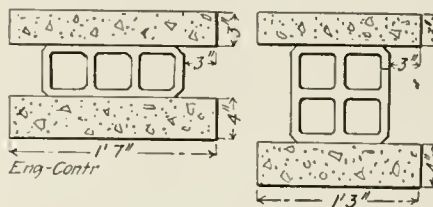


Fig. 1.

which experience and experiments have shown to reduce construction costs or to improve the structure.

New Methods of Laying Vitrified Clay Tile.—In the new standard construction a 4-in. foundation of concrete is first laid which will extend 3 ins. beyond the outer walls of the conduit. The tile is then laid

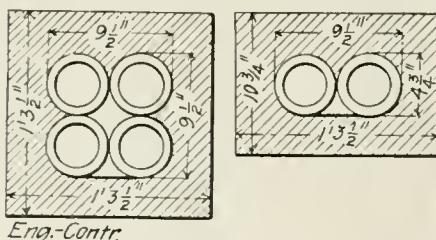


Fig. 2.

on this foundation to make the number of ducts desired. The tiles should be carefully butted, and centered and aligned by dowel pins, using at least two pins at each joint. When two or more tiles are laid all joints should be broken or staggered. Each joint is protected by a strip of muslin or burlap which should smoothly extend over

the end of each section of conduit at least 3 ins. on each side of the joint and should lap at the top for at least 6 ins. This muslin or other cloth is first thoroughly soaked in water, then laid out flat, and to it is applied a thin coating of neat Portland cement paste. After the joint has been thus made the entire surface of the muslin or other cloth is covered with a ¾-in. layer of mortar not leaner than 1 part Portland cement and 1 part sand.

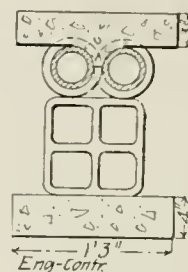


Fig. 3.

After the required number of ducts have been laid out and jointed and the joints set, the sides of the trench are filled with thoroughly tamped earth to a height level with the top of the upper tier of ducts. A layer of concrete 3 ins. thick is then placed over the ducts extending 3 ins. on each



Fig. 4.

side beyond the outside line of the ducts. The method of construction is shown by Fig. 1.

This method of laying tile is considerably cheaper than the method which it supplants of encasing the tile in 3 ins. of concrete on all sides. It means a saving in concrete of 0.01 cu. yd. and a saving in

TABLE 1.—COMPARATIVE COST PER LIN. FT. OF DIFFERENT METHODS OF LAYING CONDUIT.

	Cost of vitrified clay tile laid as in Fig. 1.	Cost of vitrified clay tile encased in 3" of concrete.	Cost of stone conduit laid as in Fig. 2.
Concrete	\$0.1075	\$0.1463	\$0.1652
Dowel pins	0.0022	0.0022	0.0022
Burlap 6" wide	0.0054	0.0054	0.0054
Duct	0.1600	0.1600	0.1800
Unloading and distributing material	0.0134	0.0134	0.0141
Excavating	0.1254	0.1254	0.1273
Teaming	0.0310	0.0320	0.0334
Mixing, handling and dumping concrete	0.0343	0.0513	0.0597
Laying ducts	0.0301	0.0301	0.0198
Filling in	0.0408	0.0408	0.0129
Foreman, timekeeper and watchman	0.0301	0.0304	0.0314
Total cost	\$0.5802	\$0.6373	\$0.6738

Note:—Wages per day of 8 hrs.: Laborers, \$2.00; teams, \$5.50; foreman, \$3.50; timekeeper, \$2.25; watchman, \$2.00.

labor of \$0.183 per lin. ft. of 4-duct conduit, and a proportionate saving in larger or smaller multiples. The comparative cost of both methods is given in Table I.

Method of Laying Stone Conduit.—The trench is first prepared with a foundation of 3 ins. of concrete. Upon this the stone conduit is laid and settled in place, care being taken to see that the lengths butt solidly together within the aligning collar.

TABLE II.—COMPARATIVE COST PER LIN. FT. OF TRIANGLE AND STANDARD 3-DUCT CONDUITS.

	Cost of triangle 3-duct laid flat and encased in 3" of concrete.	Cost of triangle 3-duct laid on edge and encased in 3" of concrete.	Cost of standard 3-duct encased in 3" of concrete.	Cost of standard 3-duct laid as in Fig. 1.
Concrete	\$0.1023	\$0.1023	\$0.1461	\$0.1357
Dowel pins	0.0022	0.0022	0.0033	0.0033
Burlap 6" wide	0.0043	0.0043	0.0080	0.0080
Duct	0.1200	0.1200	0.1200	0.1200
Unloading and distributing material.....	0.0109	0.0109	0.0118	0.0118
Excavating	0.0952	0.0931	0.1079	0.1079
Teaming	0.0278	0.0272	0.0292	0.0286
Mixing, handling and dumping concrete.....	0.0346	0.0346	0.0471	0.0412
Laying ducts	0.0283	0.0294	0.0349	0.0333
Filling in	0.0341	0.0338	0.0352	0.0340
Foreman, timekeeper, watchman.....	0.0280	0.0273	0.0298	0.0292
Total cost	\$0.4877	\$0.4851	\$0.5733	\$0.5530

When two or more ducts are laid side by side, all joints should be broken or staggered. When the ducts are laid they are enclosed at sides and top with a wall of concrete 3 ins. thick. The conduit should be thoroughly wet before being laid, so as to insure the joining of the surrounding concrete to the conduit. If the conduit is of large cross section it is built up in tiers. The formation is built up to its complete

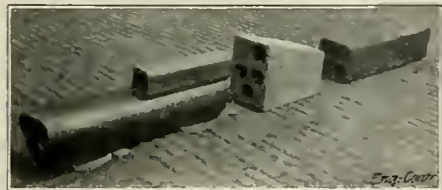


Fig. 5.

size and retained in position by clamps until concrete is installed. The method of laying the conduit is shown by Fig. 2, and the cost is given in Table I.

Triangle 3-Duct Conduit.—This duct is laid eight on edge or flat and is encased in 3 ins. of concrete. Compared with Standard 3-duct (Fig. 1) its advantages are that, due to its truss construction, it can be made in 3-ft. lengths, the same as 4 and 6-

duct, whereas the standard 3-duct is made in 2-ft. lengths. This makes a saving in handling in making joints, and in dowel pins. It is cheaper to install than the standard 3-duct whether encased in concrete or laid with a concrete foundation and top, as it requires a smaller trench and less concrete. A triangle 3-duct is cheaper to install with a 2-duct in forming a 5-duct conduit than a standard 3-duct and a

2-duct, as it requires a smaller trench and less material.

The comparative cost of the different methods of laying both styles of 3-duct and both methods of forming a 5-duct conduit are given in Tables II and III, respec-

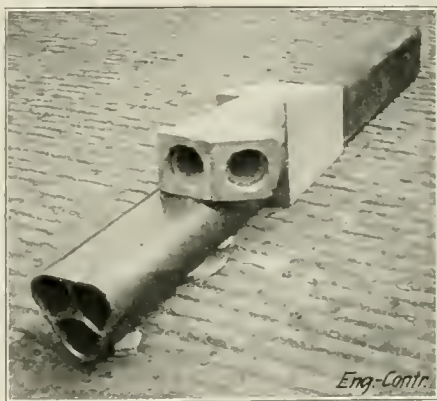


Fig. 6.

tively. These tables are based on the same rates of wages as Table I.

Method of Laying Laterals in Main Trench.—Laterals when laid in main conduit trench are built of 3-in. sewer tile or vitrified clay tile. They are placed at the

TABLE III.—COMPARATIVE COST PER LIN. FT. OF DIFFERENT METHODS OF LAYING A 5-DUCT CONDUIT.

	Cost of laying a standard 2-duct with a triangle 3-duct on top, encased in 3" of concrete.	Cost of laying a standard 3-duct with a 2-duct on top, encased in 3" of concrete.	Cost of laying a standard 3-duct with a 2-duct on top, with concrete top and bottom.
Concrete	\$0.1417	\$0.1811	\$0.1353
Dowel pins	0.0038	0.0049	0.0049
Burlap 6" wide	0.0108	0.0145	0.0145
Duct	0.2000	0.2000	0.2000
Unloading and distributing material.....	0.0151	0.0159	0.0159
Excavating	0.1301	0.1558	0.1558
Teaming	0.0352	0.0291	0.0386
Mixing, handling and dumping concrete.....	0.0424	0.0625	0.0408
Laying ducts	0.0352	0.0491	0.0476
Filling in	0.0541	0.0577	0.0559
Foreman, timekeeper, watchman.....	0.0338	0.0382	0.0364
Total cost	\$0.7022	\$0.8185	\$0.7457

top of the conduit formation and beneath the upper layer of concrete (Fig. 3).

Where a lateral is to be laid for a considerable distance in main trench an economical method of installing is to increase the multiple of the main conduit and then spread the duct at a point near where the lateral takes separate trench. This is done

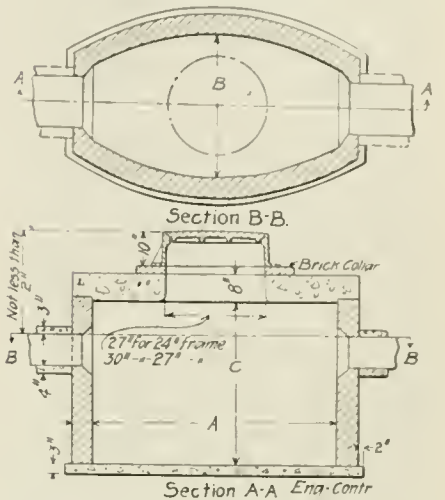


Fig. 7.

by means of a concrete section as shown by Figs. 4, 5 and 6.

The advantage of this method is that it considerably reduces the cost by decreasing the size of cross section, the volume of concrete required to encase, and the amount of labor needed in laying tile and mixing concrete.

Manhole Construction.—In the construc-

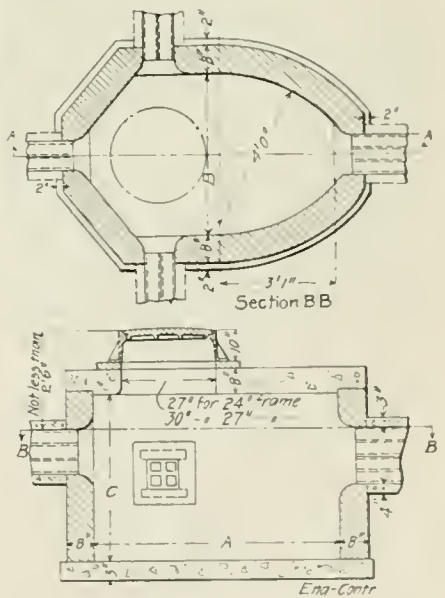


Fig. 8.

tion of manholes shown by Fig. 7, the length of the manhole has been increased, the thickness of floor has been reduced 3 ins. and a round cover is used instead of a square cover. The object of increasing the length of manholes is to afford more room for cables, and the change in style of cover is designed to facilitate the han-

ding of covers and to afford a better opening for entering manholes. Figure 8 illustrates a type of manhole which has become generally adopted on intersecting conduit runs. Its advantages over the octagon and other styles of manholes for intersecting conduits are that it has no angular corners or sharp edges against which cables can be cut or injured, and it affords more cable room in proportion to its size than any other style of manhole.

The standard manhole or vault is either brick with concrete floor, concrete top and cast iron frame and cover, or of concrete throughout, with cast iron frame and cover. On all manholes a collar of brick work at least 8 ins. wide horizontally and laid in cement mortar is placed upon the concrete top as a seat for the manhole frame, in order that the slope of the cover shall conform to that of street surface and to allow for a reasonable lowering of the street grade at some future time without necessitating expensive reconstruction of the manhole.

In forming manhole tops moist sand should be packed in along the intersection

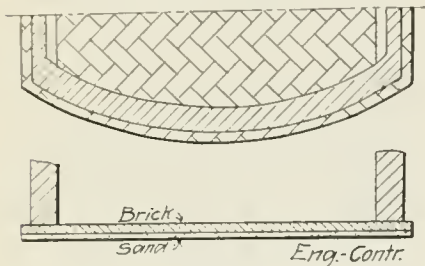


Fig. 9.

of the form for the neck opening in such a manner as to leave a rounded edge of the opening, of approximately $1\frac{1}{2}$ ins. radius.

Where a concrete floor is used, it should be 3 ins. thick. Where the soil is sandy and well drained, concrete floors may be omitted entirely or floors may be made of cinders or loose brick as shown in Fig. 9. This method obviates making sewer connections which are often expensive, and it affords drainage in districts where no sewer system is installed.

In the 21 months since the beginning of construction work on the sanitary sewer system of Baltimore, Md., 25.6 miles of sanitary sewers and storm-water drains have been completed at a cost of \$2,474,557, the work involving the excavation and placing of 527,744 cu. yds. of excavation, 181,174 cu. yds. of embankment, 58,853 cu. yds. of concrete and 7,636 cu. yds. of brick work, including the work at the disposal site. At present there are engaged in the work about 1,700 men, 141 teams, 64 engines, boilers and pumps, 2 steam rollers, 4 steam shovels, 6 trench machines, 35 diggers, scrapers, etc., 10 concrete mixers, 5 derricks, 8 cableways, 10 locomotives, 92 dump cars and 4 miles of railway tracks operated by contractors

The Reconnaissance of Irrigation Systems with Some Cost Data on the Crow Project, Montana.*

BY J. C. CLEGHORN, C. E.

Methods of reconnaissance depend on the purpose of the survey. The first investigations are, perforce, approximate only and decide in a general way the relations of the various factors. Since it is not known at the outset whether it will pay to construct the project, the first investigations must be of the cheapest and most rapid kind. Suppose after driving over the project and forming a tentative plan, the next thing desired is to find a diversion point on the river to cover the tract in question. Starting at the highest point on the tract, or at some controlling point near the land, the usual method is to run a fly level line up the river till sufficient head is obtained to carry the canal upon the land. When a suitable diversion point is found at the approximate elevation, a canal line is run back following the contour.

Wilson, in his "Irrigation Engineering," says: "The first trial line or two of levels run as above serve practically as preliminary lines. They should, therefore, be run with long sights, there being rarely any necessity for great care and accuracy. In all work of this sort it is unnecessary to conduct any other form of survey than a mere level line, the chief object being to ascertain the relations of the elevations of the proposed sources of water supply and the irrigable lands."

Although he does not say so, this author evidently apprehends the level line to be run on the contour and the distance estimated by pacing or stadia measurements. Otherwise he would have no comparison between two lines. Distance can be estimated very closely by pacing. The writer does not agree with Mr. Wilson in regard to only a level line being needed. A level line can be run with a transit or plane table and a compass, or a plane table stadia traverse can be carried about as cheaply as a level line, with the added advantage of rendering possible the construction of an approximate map. When a little care and time are added in taking topography notes and sketches, with a few stadia shots at important points, the survey becomes a very fair preliminary line from which an estimate may be made of the cost of construction. Of course no set rule can be given for this kind of work, as conditions vary largely. Sometimes the location of the entire canal is practically fixed by natural features such as canyons, rock cliffs, bluffs, benches, cross drainage or other natural features. A canal line is different from a railway line in that it must follow a falling contour, nearly level. It may make drops, span gulches on trestles or go under in a siphon, but it cannot climb out of a predicament as can a railway line. In other cases a number of trial lines must be run

in order to correlate the various factors and make a comparison of cost. Possible drops, various creek crossings, alternate tunnel and open ditch sections all have more or less influence on the line above and below them.

The purpose of a reconnaissance line is, however, usually to determine the feasibility of a project and the difficulties to be met with. As remarked, it should be as rapidly and cheaply run as possible. The first lines undertaken by the Reclamation Service are nearly all reconnaissance lines, yet they are run with extreme care and at great expense, somewhat as follows: A level line is run and hubs set in the ground at intervals of 600 ft. upon which to turn, making the level shots 300 ft. long. The party consists of a levelman, a rodman, stake artist and teamster. The stake artist drives the turning points and marks the elevation of the point and station number on a guard stake, usually a piece of lath. The transit party, consisting of a transitman, head rodman, back flagman and teamster, runs a stadia traverse over the stations, reading horizontal angles and magnetic bearings as a check. These notes are plotted on detail paper to a scale of from 500 to 1,000 ft. to the inch by the camp draftsman and pricked through on heavy linen mounted plane table sheets which are carried into the field by the plane table party. Topography is taken from 200 to 1,000 ft. on each side of the line.

An effort in one instance to cut expenses resulted, first, in the taking of topography by the transit party and finally with the hand level. A topographer with a rodman can sketch several miles of line in a day and cover several hundred feet on each side of the line. This method is very good where the conditions fix the canal line within narrow limits and it is desired to make a paper location, but the usual irrigation canal is anything but fixed and demands considerable work before location is begun. The writer does not favor paper location, as experience has shown that it is impossible to follow it in the field, which compels resort to field location in the end.

For purposes of approximate estimate within the limits of reconnaissance a stadia line as follows seems to be the best, all things considered. A level line is run with stakes set on the contour as mentioned before, but with the following vital difference: Some one experienced in location, presumably the chief of the party, does the rodding and picks the line, following as closely as possible a line as he would locate it on the contour, and setting stakes at some even paced interval, say 200 ft. These stations are tied in with a transit for map purposes. A profile can be made from the combined transit and level notes which will approximate that of a located line over the same ground. An estimate of this kind of a line will be on the safe side, as it can be improved on somewhat when location is attempted.

*Abstract of a paper in the "Iowa Engineer" for July, 1908.

A very important part of reconnaissance is the examination of reservoir sites, which may call into play all of the previously described methods of work. A profile of the dam site must be had from which to estimate the cost of a dam. The capacity in acre feet is best obtained by making a plane table survey of the reservoir and measuring the water areas at various heights with a planimeter. To check the plane table work or, as a base line, the top contour may be run out with a level and transit traverse, as previously described. With the data thus obtained, the storage capacity and cost per acre foot are easily computed.

In the consideration of an engineering problem the first question usually asked is, what will it cost? In this connection it may be of some interest to describe some reconnaissance work on which the writer was engaged and on which reliable cost data are available. The lines were run by members of the United States Reclamation Service on the Crow Indian Reservation, in the year 1904, to determine what feasible irrigation projects there were for immediate construction. The Crow Reservation is situated south and east of Billings, Mont., is bounded on the north by the Yellowstone River and traversed from south to north by the Big Horn River, which cuts through the edge of the Big Horn Mountains in its way north. The Burlington and Northern Pacific railways traverse the reservation from east to west and offer good transportation to possible products of the soil. Along the Yellowstone and other streams there are fine bottom lands varying from a few hundred feet to three or four miles wide. Above these rise some fine, gravelly bench lands, and still higher up is a rolling and in some places very rough plateau. Most of the area will never be of value except as a pasture for sheep and cattle or limited dry farming, but there are several fine tracts awaiting the water.

Early in 1904 Mr. Drummond was sent to make an examination, and reported, May 11, 1904, that the following lands might be irrigated: The low lands on the west side of the Big Horn River from near its junction with the Yellowstone River to Two Leggin Creek, which were said to comprise 45,000 acres, 10,000 acres of which were within the Fort Custer Military Reserve; the high bench lands west of the Big Horn River and extending from the north of Big Horn Canon to Pine Ridge.

It was thought that 20,000 acres on the diminished reservation and 17,000 acres on the ceded strip might be covered by a high line, which, if high enough to get over the divide near Toluca, might cover 50,000 acres on the Yellowstone slope; also 1,000 acres east of the Big Horn and near its mouth.

Mr. Drummond also mentioned the Huntley tract of 40,000 acres, extending east from Huntley along the south side of the Yellowstone River, as also a strip of

about 30,000 acres extending east from Meyers Station to Forsyth. After an examination by Assistant Chief Engineer Davis and C. W. Fitch, Mr. Robert S. Stockton was assigned engineer in charge of the investigations.

The first party began May 27, 1904, and ran a fly level line from Toluca up to the Big Horn Canon to determine at what elevation a canal should be started to get over the divide to Fly Creek. It was found that a diversion dam 150 ft. high must be used to get a sufficient elevation. The fall of 10 ft. per mile in the river prevented getting the elevation by diversion higher up in the canon.

This work consisted of a level line which aggregated about 100 miles at a cost of \$10 per mile. The Big Horn High Line was started July 1 by Mr. Geo. E. Straton, assistant engineer, and consisted of a level line on the falling contour tied in by a transit stadia traverse and followed by the plane table, taking sheets on a scale of 200 ft. to 1 in. This line was 92.8 miles long and was followed by the Peritsa Lateral 32 miles long. The two cost \$31.97 per mile for the level and transit lines. There were 92 plane table sheets made of the Big Horn High Line at a cost of \$20.87 per sheet and about that per mile. The party was composed as follows:

	Per Month and Board.
Chief of party.....	\$133.33
Transitman	75.00
Levelman	60.00
Rodman	45.00
Rodman	45.00
Rodman	45.00
Chainman	40.00
Flagman	40.00
Cook	55.00
Teamster	45.00

The party ran a careful survey in the manner described. The chief of party was sometimes instrumentman, the transitman ran the table most of the time and the levelman ran the level one day and transit the next. The first few miles were rough and on steep side hill, but beyond that the country was gently sloping.

Mr. Straton then ran out the Fort Custer line a distance of 45 miles at a cost of \$22.53 per mile. This line is much nearer water than the other two, hence the drives to and from work were shorter.

About the same time Mr. Henry R. Evans was started on the special detail topographic sheets at the Big Horn dam site, the Fort Custer diversion site, the Toluca Cut and at the Huntley Bluffs. This party did the careful topographic work on a scale of 100 ft. to 1 in., and was composed as follows:

	Per Month and Board.
Chief of party.....	\$116.00
Station assistant.....	45.00
Rodman	40.00
Rodman	40.00
Cook	50.00
Teamster	10.00

Thirteen sheets were made at a cost of \$76.92 per sheet.

In the early part of August Mr. E. D. Hendricks started work at Huntley and ran out the Huntley Canal line a distance of 36 miles, the Ballantine pump line, 6 miles long, the Waco ditch line, a distance of 19 miles, the Sanders High line, a distance of 45 miles, and a line up Tullocks Fork, 8 miles. These lines were run as before except the transit took topography along with traverse. It has the advantage of being faster. The company was composed as follows:

	Per Month and Board.
Chief of party.....	\$100.00
Transitman	75.00
Levelman	55.00
Rodman	50.00
Rodman	45.00
Rodman	40.00
Cook	50.00
Teamster	10.00

These lines cost \$25.51 per mile. A series of topographic sheets were taken on the Waco Sanders line along the rough bluffs between the mouth of the Big Horn River and Meyers Station, a distance of 11 miles, at a cost of \$20.91 per mile.

The activities in the building operations during June, as shown by the value of building permits granted in some fifty leading cities, according to the Bureau of Statistics of the U. S. Department of Labor and Commerce, indicate quite distinctly the improvement over the preceding months of the first half of the year. Even compared with 1907, June shows only a decrease of 15 per cent. Substantially the same cities which showed declines in activity in the first part of the year show relatively smaller declines for June. New York shows a large loss, attributed mainly to the Borough and Brooklyn, which is, however, on the other hand, offset to a large extent by a gain of 35 per cent in Manhattan. Baltimore, Birmingham, Cincinnati, Columbus, Denver, Duluth, Grand Rapids, Milwaukee, Pittsburg, St. Paul, Syracuse and Worcester all show substantial gains over June of last year. Milwaukee and Birmingham head the list with gains of 62 and 57 per cent, respectively, over a like period last year. Chicago and Philadelphia are each holding close to the 1907 records.

The French Government has awarded a contract for dredging and deepening the river Loire in France, between St. Nazaire and Nantes. The contract which was awarded to Tillbury Contracting & Dredging Co., Ltd., involves the removal of 7,850,000 cu. yds. of earth.

The earnings of India Railways during the fiscal year, April 1 to March 31, 1907-8, were \$155,000,000, compared with \$120,330,000 last year.

Methods and Costs; Some Old; Some New.

Approximate Cost of Street Car Barns.

—Messrs. H. T. Campion and William McClellan in a paper on "The Design of Railway Structures," read before the American Street and Interurban Railway Association, give the following approximate costs, drawn from experience, of different types of car barns and shops:

	Per sq. ft.
Timber barn, two-track bays, sides covered with corrugated iron	\$0.55 to \$0.70
Timber barn, three-track bays, brick or stone walls.	1.10 to 1.30
Fireproof concrete barn, three-track bays, concrete or brick walls	1.25 to 1.50
Clear span steel roof, eight to ten tracks, brick walls.	1.40 to 2.00

Replacing Old Timber Box Culverts With Cast Iron Pipe.—On the Chicago, Milwaukee & St. Paul Ry. old wooden box culverts which have outlived their usefulness are almost invariably replaced with cast iron pipe, which is laid through the old culvert and earth tamped in between the two. The old timber culvert is not removed, the iron pipe being put in a section at a time, and the space between the two well packed with earth. This brings about conditions favorable for the iron pipes, as the embankment has already settled, and as the timber culvert gradually rots away the overlaying material arches over the pipes so that they never get the full load due to the depth of embankment above them.

Repair Bail for Rod Tools.—When the bail in the swivel of rod tools parts, a quick repair, according to The Drill Hole, can be made by using a rope bail. The method of making this bail is as follows: Take a piece of 7/8-in. soft rope about 2 ft. long and splice a close eye on each end; an eye that when finished will require quite a little power to force it over the lugs on the swivel. Take enough tucks in the splices so that the distance from the top of the tool to the loop of the bail does not exceed 5 or 6 in. Keep the tools hitting on the spring of the cable and it will be found a bail is obtained which, in some respects, is superior to the metal one, as it does away with nearly all the noise of the swivel, and owing to the slight spring which it has, is much easier on the ball bearings. Owing to the breaking of the metal bail while on a railroad blast hole job in Kentucky, one contractor was forced to use one of these rope bails, and so well did he like its work that he used it all through the job, lasting about five weeks. The rope that he made his bail from was an old, worn piece of 7/8-in. soft manila, which he found, after

five weeks of steady work, to be in apparently as good a shape as when he started. He believes that if good new rope were used a bail would last four to six months.

A Method of Checking Levels.—We are indebted to Mr. J. McLane Tate for the following method of checking levels:

First H. I.—Last H. I.=D₁.

First Elev.—Last Elev.=D₂.

First B. S.—Last F. S.=D₃.

D₁—D₂=D₃.

An example will show the application of the method:

First H. I. 103.250

Last H. I. 101.200

D₁ 2.050

100.000 First Elev.

98.040 Last Elev.

1.960 D₂

First B. S. 3.250

Last F. S. 3.160

D₃ .090

D₁ D₂ D₃

2.050—1.960=.090

A sample page of the level book showing the above readings is as follows:

	Left-hand page	Right
Sta.	B.S.	H.I. F.S. Elev. Remarks
—	3.250	103.250 100.000 on Hub
—	0.250	102.250 1.250 102.000 on Rock
—	2.070	101.200 3.120 99.130 on Rock
—	.....	3.160 98.040 on Rock

Method of Testing Accuracy of Spacing of Cross Section Paper.—In a discussion of a paper read before the Engineer's Club of Philadelphia, Mr. Carl Hering gave the following description of a simple way of testing the accuracy of the spacing of cross-section paper of the usual kind in which the spaces are intended to be equal. If a piece of such paper be held in a stereoscope so that the vertical lines seen by one eye become superimposed upon different vertical lines seen by the other eye, then if the horizontal spacing is accurate the paper will look flat; but if the spacings are not all equal, some of the vertical lines will appear to be nearer to the eye and others farther off, due to the stereoscopic effect produced by the stereoscope; in other words, there will be a perspective effect and the lines will look like a series of stretched strings which are not all in one plane. This test applies only to the vertical lines; to apply it to the horizontal lines the paper must be turned so that they become vertical. A cheap quality of paper in which the spacing is not accurate presents quite an interesting appearance in the stereoscope, sometimes appearing like a series of steps viewed from above. With a little training it becomes very easy to make this test without any stereoscope by forcing each eye to look at a different group of lines and then adjusting

the eyes so that these lines become superimposed. This becomes easier to the untrained eye if a hole is cut in a piece of paper held between the eye and the cross-section paper, then looking at the latter with both eyes, through the hole; each eye will thereby be shielded from the lines seen by the other eye. By moving the paper with the hole in it nearer to, or farther away from the eyes, different sets of lines may be easily superimposed, thus different parts of the latter may be tested. Instead of a piece of paper with a hole in it, a strip of paper may be used, or the finger may be held before the eyes so as to shield from each eye the lines seen by the other. A little training enables one to do this without any intervening shield. Of course, only vertical lines can thus be tested, and they should be held quite vertically; if they slant to the right or left, the eyes cannot adjust themselves. Logarithmic paper when examined in this way ought theoretically to give the appearance of lines on a regularly curved surface, curving away from or toward the eye, as the case may be. If not accurately spaced, the appearance will be that of a series of lines at irregular distances from the eye, like the trees along the edge of a woods looked at diagonally.

Pulling Bridge Fier Back Into Place.

A 50-ft. wooden trestle at the east pier of a wagon bridge was replaced by concrete wingwalls and earth and gravel fill. The height of the pier above the surface of the ground was 19 ft., and the length of wing walls was 30 ft. The earthwork fill contained 520 cu. yds. Contrary to the instructions of the engineer, the bridge pier, which was of brick, was not anchored to the bank behind before the concrete walls were built and fill put in, and heavy rains and high water coming soon after the work was completed, the thrust of the mass behind the pier caused it to lean at top about 2 in. and possibly slide some on its base, so that one set of expansion rollers on opposite pier left their caps. To remedy this, three iron rods 1 1/4 in., furnished with long S-arms and screw taps and turnbuckles, were inserted into drill holes through the pier near the top, and the other ends carried through the trunks of trees standing on the bank some 50 or 60 ft. away, and the pier was then brought to plumb by means of crowbars working in the turnbuckles, the dirt having been first shoveled away from the back of the pier. Another set of rods was used to pull the bridge forward on the pier plates, and these rods were left anchored, holding bridge and pier in place, while the pier rods were permanently anchored in "dead men" of 3 cu. yds. of concrete each. After these concrete masses had set, the bridge stays were removed and the earth fill again put in place.

The Effect of Automobiles on Macadam Roads.*

BY LOGAN WALLER PAGE.†

It is to Tresauget, engineer-in-chief of the District of Limoges, that we are indebted for the first scientific treatise on broken stone road construction. He clearly specified several types of broken stone roads, one of which, in quite general use throughout England and America today, is known as the Telford road. It is a matter of interest that while roads of the Tresauget type are in extensive use throughout England and America, they are rarely seen in France, the macadam type having almost entirely superseded it. Tresauget's report to the Council of Bridges and Roads, written in 1775, on road maintenance is, in my opinion the best ever written on the subject. Following Tresauget, McAdam made his splendid contribution. Since the time of these great engineers many improvements and modifications have been made in road building, the most important of which have been largely brought about by time and labor-saving machinery.

It is not my purpose to consider the history of road building, and I have only alluded to it for the purpose of showing that the broken-stone road of today has been of slow development. Although the methods of construction vary somewhat in different countries and different localities, the main object sought has always been the same: to withstand the wear of iron-tired horse vehicles at a reasonable cost. Until the last decade these conditions have been successfully met, and the broken-stone road was all that could be desired. Under modern motor traffic, however, the conditions have changed. Roads which formerly withstood the wear of horse vehicles are now quickly denuded of the fine binding material, and become loose and disintegrated. On the principally traveled roads, the great clouds of dust raised by rapidly moving motor vehicles are not only a great waste of the material of which the road is composed, but this dust is carried by the wind and disseminated over adjacent property to such an extent that it has, in many instances, affected the value of real estate as well as the comfort of nearby residents and pedestrians. The road surface becomes so loosened that water makes its way to the foundation, and in general the cost of maintenance has very greatly increased. With a constantly increasing motor traffic these are, briefly, the conditions we find today, and which have to be met. The problem is such a serious one that it has called forth the best efforts of highway engineers in every civilized country. By the proper use of bituminous materials, the mechanical difficulties have in a large measure been overcome, but the cost of such treatment is so great that it is hard to believe at present that such methods can ever be general-

ly used on the many thousand miles of rural highways affected.

As already stated, the broken stone road has been developed to withstand the wear of iron-tired horse vehicles, and has met successively the demands of suburban and rural traffic until the advent of the motor vehicle. When in its highest state of perfection the rock from which such a road is made is so suited to the volume and character of traffic which passes over it that the amount of dust worn off is only sufficient to replace that removed by wind and rain. The dust remaining should be just enough to bond the surface stones thoroughly, forming a smooth, impervious shell. A road of this character wears uniformly under the traffic for which it was designed, and when properly maintained always presents an even surface.

When such a road is subjected to continuous fast motor traffic entirely new conditions are brought about. Since the advent of this new traffic, its effect on the road has been the subject of much study by both highway and mechanical engineers, and many highly interesting and ingenious theories have been advanced to account for the injury to roads derived from it. While the slipping of the tire, skidding, shape of car body, suction and other causes contribute more or less to the injury of the road surface, I think it is quite generally agreed that the suction of the pneumatic tire on the surface is the main cause of the trouble. The object of this paper is to show, however, that the great tractive force or shear exerted by the driving wheels of motor cars is the main factor of injury.

It has been demonstrated by connecting both front and rear wheels of motor cars with separate speedometers that there is a considerable amount of slipping of the driving wheels on the road surface, and, on account of the numerous irregularities on the average road surface, this is what should be expected. This slip, due to the decrease in the bearing surface of the tire, undoubtedly increases the amount of finely divided material of the road surface thrown into the air. The increased amount of damage done on this account will be in proportion to the irregularities in the road and the speed of the car. While it is an important factor, its effect is greatly reduced if the road has a smooth surface.

The effect of skidding is only observable on roads that are subjected to a considerable volume of fast motor traffic, and only then on curves. The result of this is to shift the crown of the road tangentially to the gutter. While very annoying to those having the maintenance of such roads, it is not one of the serious or costly causes of injury, as it is generally confined to rather sharp curves.

It is my belief that too much stress has been laid upon the effect of the car body and its shape in removing dust from the road surface. After a number of experiments and observations, I am now convinced that little or no dust is removed

from the road surface by this means, except on very dusty roads. The dust lifted by the wheels, however, is greatly accelerated by the action of the car body and the air currents set up in its rear, which has much to do with the dissemination of dust. This is one of the important factors to be considered, as much of the dust lifted by the wheels would not be carried from the road but for the air currents developed by the car body, and these, of course, are much affected by its shape.

Probably no single factor has been considered of as much importance as the so called suction of the pneumatic tire. Some writers have even gone so far as to maintain that a slight vacuum is created in the rear of each tire, which is sufficient to lift the finer particles of the road surface in the air. In my opinion, entirely too much importance has been given to this phenomenon, for if it exists at all, its effect is probably so slight that it can be considered a negligible quantity, and I shall endeavor later on to give my reasons for this view.

Beyond a doubt the most injurious action of motor traffic is the great tractive or shearing force exerted by the driving wheels of these cars. The fine dust which ordinarily acts as a cementing agent to the road surface is thrown into the air to be carried off by the wind, or that remaining on the road is so loosened that it is easily washed into the gutters by rain. The pneumatic rubber tire wears off from the broken stone of the road little or no dust to replace that thus removed, and the result is that the stones become loose and rounded, giving the greatest resistance to traction and allowing water to make its way freely to the foundation of the road.

For the purpose of studying this phenomenon I recently conducted a series of tests with motor cars of various shapes and sizes, from the 4,000-lb. limousine to the small runabout. These cars were run at various rates of speed, and their effect studied on a section of average broken stone road. The most interesting result was obtained with a 60-hp. car stripped for racing. The wheels of this car were 36 ins. in diameter, with 4-in. front tires and 4½-in. rear tires. The weight of the car with driver and mechanism was 2,800 lbs. This car was driven over a level section of broken stone road at speeds varying from five miles an hour to sixty miles an hour. The road used was a section of a government road which had been resurfaced two years previous to the test and was in very good condition. Up to fifteen miles an hour little or no effect was produced on the road, and even at twenty miles an hour it was judged by those present that no serious damage was done. From twenty miles an hour on, however, the effect was markedly noticeable with each increase in speed. At a point on the road designated for the proper speeds, photographers with the necessary high speed cameras were stationed for the purpose of taking photographs from different points of view of the

* An address delivered before the Legislative and Good Roads Convention, Buffalo, N. Y., July 7, 1908.

† Director U. S. Office of Public Roads.

effect produced. These photographs, I think, illustrate the action of the wheels very clearly. They show the car traveling at various rates of speed from five miles an hour to sixty miles an hour.

The chief point of interest in these photographs is the difference in effect on the road between the front and rear wheels. Now if it is true, as has been claimed, that a vacuum is formed in the rear of the pneumatic tire, or that it possesses any power of suction, this should be equally true of both front and rear wheels. I am convinced after most careful observation that this is not the case, and I think this point is illustrated by the photographs.

To sum the matter up briefly, the pneumatic tire or any type of tire which propels a vehicle, must have sufficient tractive resistance to overcome the load of the vehicle. This of necessity must cause a shear on the road surface, which varies with the weight and speed of the vehicle. The broken stone road surface has little power to resist a shearing stress, consequently the fine material of which it is composed is thrown into the air. Once lifted from the road, this fine material is subject to the effect of air currents generated by the car body, and subsequently by the wind. In this manner large quantities of the material of which the road is composed is carried from the road and must eventually be replaced, or the road will rapidly deteriorate. This action may be greatly accelerated by other causes, but in the main it is sufficient to account for the observed results. Aside from the dust carried from the road in this manner, this shearing force of the motor car has a decided disintegrating effect on the surface of the road.

Plans are now in preparation for grade crossing work at Baltimore, Md., which will involve the expenditure of about \$12,000,000.

Under the requirements of a new English patent law which goes into effect on Sept. 1, patentees who wish the protection of the British patent laws must manufacture their products in the United Kingdom.

The site is now being cleared for the new Chicago terminal station of the Chicago & Northwestern Ry. The station will occupy about four city blocks and will have its main front on Madison street, between Canal and Clinton streets. The building alone will cost about \$4,000,000, while the approaches, with elevated tracks will cost about \$8,000,000. Land and right of way will cost another \$8,000,000, making a total cost of \$20,000,000. The building will be built of gray granite and will have three main floors. The main entrance will have a colonnade 120 ft. high, and the six main stairways will have an aggregate width of 100 ft. It is expected to have the station completed early in 1910.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0856. **Engineering Instruments.**—The Hanna Mfg. Co., Troy, N. Y.

This 72-page indexed catalog besides listing a full line of engineering instruments makes an unusually complete text book on the care, adjustment and use of instruments. A particularly valuable feature is the section giving in detail Mr. Clark Brown's "Chart Method of Reducing Polaris Observations." By this method it is possible to establish the meridian at any time Polaris may be seen, instead of waiting for culmination or elongation as formerly. Surveyors will do well to secure the catalog for this section alone.

No. 0857. **Universal Unit System for Concrete Reinforcement.**—Universal Unit System, 132 Nassau St., New York.

This 15-page pamphlet explains a system of "unit connections" which may be used for connecting up into unit forms any arrangement of loose bar reinforcement for concrete structures. As stated in the pamphlet the unit connections are made in straight plates any practical handling and packing length; rings and segments for circular and semi-circular work (fasteners on outside or inside or inside of radius, as preferred); squares and corners for all square construction; separators, spacers, bridges, triangles, specials, etc., for every purpose; stirrups, verticals, diagonals, hangers, etc., from flat and round steel, in every practical design and dimension, with looped, plain or hooked ends.

No. 0858. **Hovland Tile Ditcher.**—St. Paul Ditcher & Carrier Co., St. Paul, Minn.

The machine described in this 8-page pamphlet is a ditching machine for tile drainage work. The machine both digs the ditches and lays the tile. Illustrations are given of the machine in operation and of special working parts.

No. 0859. **Concrete Mixers.**—Municipal Engineering & Contracting Co., Chicago, Ill.

This 65-page pamphlet describes and illustrates the various styles and sizes of Chicago Improved Cube Concrete Mixers, with tables of weights, sizes, capacities, etc., and with regular or special equipment. There is also matter regarding charging hoppers, automatic measuring water tanks, concrete hoists, etc. The advantages of the cube principle of mixing are presented by argument and illustration and there are several tables of useful data for concrete workers.

No. 0860. **Reinforcing Bars.**—William B. Hough Co., Chicago, Ill.

This 24-page pamphlet presents in a convincing manner the claims made for M/B cold twisted steel bars as a superior reinforcement for concrete. The argument is well worth reading and the formulas and tables for designing reinforcement make the pamphlet worth keeping on file.

No. 0861. **Push Button Switch Mechanism.**—The Cutler-Hammer Mfg. Co., Milwaukee, Wis.

The push button switch mechanism consists of but three moving parts, (1) a push bar extending clear through the switch, (2) a coiled steel spring and (3) a moving contact piece. These, with the fixed contacts, constitute the whole of the mechanism. The principle embodied is that of a coiled spring contracting on a tapering surface—the action being similar to that of a rubber ring slipped over the knob of an umbrella, or a coiled wire whose supporter, which, when passed over the elbow will travel a short distance up or down the arm of itself. The action is positive and snappy in either direction—in other words this mechanism gives a quick "make" as well as a quick "break," the movement of the contact piece being the same whether the push bar is moved fast or slow. Some of the advantages claimed for these specialties are set forth in this booklet. The mechanism itself and pendant switches, surface switches and lamp socket are illustrated.

Personals.

Mr. W. H. McEntry has resigned his position as City Engineer of Bessemer, Ala.

C. G. Vaughn, M. Am. Soc. C. E., consulting engineer, of Natchez, Miss., died Aug. 4, aged 51 years.

Peter L. Youngren, a civil engineer of Milwaukee, Wis., died last week at Anderson, Ind., aged 46 years.

Mr. Allen R. Boudinot has opened offices in the Lane Bldg., Davenport, Ia., where he will engage in a general civil engineering practice.

Mr. W. N. Morrill, has resigned his position as Constructing Engineer to the Sewerage Commission of Louisville, Ky., and will engage in private business.

Mr. John V. Beekman, Jr., formerly Boston Manager for Purdy & Henderson, has become General Manager for Whidden & Co., Inc., Consulting Engineers, Boston, Mass.

Mr. R. Fleming Arnott has opened an office as Consulting Engineer at 95 Liberty St., New York. Mr. Arnott was formerly Mechanical Engineer with the Hudson Cos.

Messrs. J. A. Dahlman and W. M. Dunphy have organized the Dahlman Construction Co., with offices in the Majestic Bldg., Milwaukee, Wis. The company will specialize in reinforced concrete work.

Mr. Julian Kendrick has resigned his position as City Engineer of Birmingham, Ala., and is now engaged as Consulting Engineer for the city in the preparation of plans for extending the sewer system.

Dr. George L. Adams has been appointed Geologist in the Bureau of Mines, Philippine Islands. Dr. Adams was formerly with the U. S. Geological Survey, and later was with the Corps of Mining Engineers of Peru.

Mr. P. Ney Nelson has resigned his position as Superintendent of Construction for the Rochester Ry. Co., of Rochester, N. Y., to take a position with engineering staff of the Mack Paving & Construction Co., Philadelphia, Pa.

Capt. Lytle Brown, Corps of Engineers, U. S. Army, has been ordered from Washington Barracks to Louisville, Ky., to relieve Capt. Harry Burgess, Corps of Engineers, who has been assigned to the Office of Chief of Engineers.

William J. Craig, a former contractor, died recently at Decatur, Ind. Mr. Craig at one time was President of the Western Construction Co., which had the contract for changing the Clover Leaf Ry. from a narrow to a standard gauge line.

Mr. Frederick G. Clapp, for the past seven years connected with the U. S. Geological Survey, has resigned to enter into a partnership with Mr. A. W. Bee, Jr., C. E. They have opened offices in the Fitzsimmons Bldg., Pittsburg, Pa., where they will engage in water supply, civil and geological engineering practice.

Mr. W. N. Haas, C. E., Manager of The Haas Engineering Co., formerly an Assistant Engineer on the Subway and Elevated Railway Construction of the Philadelphia Rapid Transit Co., has opened an office in the Bulletin Building, Philadelphia, Pa., where he will engage in a civil and mechanical engineering practice.

The following officers of the Corps of Engineers, U. S. Army, about Oct. 15 will report to Col. John G. D. Knight, Corps of Engineers, President of the Examining Board at New York City, for examination for promotion: Capt. Edward H. Schulz, Capt. Harry Burgess, First Lieutenant Arthur Williams, First Lieutenant Wildurr Willing, Second Lieutenant James J. Loving.

The work of the old Division of Municipal Engineering and Division of Building Construction on the Isthmian Canal, which was merged into the work of the three construction divisions on Aug. 1, will be carried on in the Atlantic Division under the direction of Mr. L. G. Thom, Assistant Engineer, and in the Central Division under Mr. G. H. Ruggles, Assistant Engineer, and in the Pacific Division under Mr. W. M. Acheson, Assistant Engineer.

Mr. A. P. Melton, City Engineer of Gary, Ind.; Mr. M. A. Caldwell, a City Trustee, and Mr. T. A. Crouse, a photographer, had a narrow escape from drowning last week, owing to the capsizing of a boat in which they were inspecting a large sewer. The party was thrown into the water, which was over 5 ft. deep and left in complete darkness three-quarters of a mile from the outlet. They were rescued by two men in another boat belonging to the inspection party.

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for Civil Engineers and Contractors.

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and

CONTRACT NEWS

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The Technical League, a New Society for the Promotion of the Economic Welfare of Engineers and Technical Men.

Thousands of engineers working on small salaries have undoubtedly believed that some organized effort should be made to better their economic condition. At last such an effort is about to be made, and the Technical League is the name of the organization whose purpose it is (quoting from the constitution) "to promote the technical, social and economic interests of its members." The editors of this journal are in hearty accord with the objects of this new organization, for there is no class of professional men so poorly paid as engineers. Indeed the average technical graduate earns less during the first five years after graduation than does the average iron worker or brick mason. It is customary to reply to this statement by urging that the technical man always has a wonderful opportunity ahead of him. Yes, and it nearly always remains ahead of him, about two laps ahead even to the finish.

A technical graduate has spent eight years preparing for his life's work, four in high school and four in college. Then he is usually asked to work four more years at a pitifully meagre salary "to get experience." "To get experience"—who isn't getting experience all his life? When does experience getting cease? If engineers must work for a pittance while "getting experience," even gray hairs will be no evidence that more than a pittance is merited.

Without at this time going further into the subject of the need of such an organization as the Technical League, and without committing ourselves to the policies we may add a few words as to the conditions of membership. Article II of the Constitution provides:

"Any person who is a Civil, Mining, Structural, Mechanical, Electrical, Sanitary, or Topographical Engineer, or Draftsman, Naval Architect or Draftsman, Architect or Architectural Draftsman, shall be eligible to membership of this League, provided he is not an employer of engineers or architects, or a representative of an employer."

Article VII provides that:

"Membership in the League shall, until the revocation of this paragraph, remain confidential with the League and its members, except that any member may disclose his individual membership. The business proceedings of each meeting of the League shall remain secret except when otherwise voted at any meeting."

It will be seen from the last provision that the intention is to have the Technical League resemble a fraternal organization. While there will be many who will oppose this feature, there is much to be said in its favor.

One of the first matters that the League will take up, we understand, is the civil service laws and their interpretation by executive officials. Civil service laws have been shamefully distorted in their application in many cities, opportunities for the promotion of technical men have been curtailed, and inadequate salaries have been provided for the men who are doing much of the most important work.

All who are interested in this new organization can obtain further information by addressing the Secretary of the Technical League, 721 Park Row Bldg., New York City.

The Importance of Records of Engineering Work.

The importance in engineering work of carefully kept records is discussed at length in a paper which we publish in another column of this issue. The author of this paper tells little of the methods to be followed and gives no forms or schedules to be employed, but simply urges the general necessity of keeping records. To many of our readers who have developed systems of recording work or who have the development of such system in mind the paper will perhaps give little information of value. It is, in truth, written for the man who does not fully appreciate the advantages of keeping records or who so keeps them that he must always be had as interpreter if they are to be used. There are many such men and it is to them that the author appeals in this article.

A record of engineering work must be such that first, it is of use to the maker, and that second, his successor can employ it with only slightly less valuable results. The writer of these remarks learned one of these facts in his very first job of "engineering," and even so late as the day of this writing he has had an illustration of the truth of the other. In between these two experiences the examples have been a multitude. Certainly there is nothing in these experiences that almost any engineer cannot duplicate from his own experience, but that is the very reason why they deserve mention and why Mr. Howard's article deserves reading and has been printed here.

That a record of engineering work which does not enable a successor to go ahead with the job without repeating any part of the previous labor is to a great extent valueless was taught the writer in his first survey. The task was to complete a survey stopped by snow and the coming of winter, and the engineer's records of the work already done were given his successor to work from. They were of no use. It was impossible for them to make sure where the previous work stopped. So far as the records went the whole of the work done the preceding fall would have had to be done over, had not the engineer who made them been located in a neighboring town whence his successor

got him to come and act as interpreter. As the writer had agreed to complete the survey for a lump sum he was saved from "going broke" on his first job only by the accidental fact that he was able to find and employ his predecessor. The lesson taught him was: Never accept a predecessor's records at their face value.

It is not so often that records are so kept as to be useless to the man who made them, but it frequently happens. It was the writer's task recently to present an argument for a firm of contractors which had for years done a certain class of excavation using a special excavating machine. The "books" of the firm were thrown open for examination. They showed the profit or loss on every job done for years, but in no way from the records was it possible to figure what the cost per cubic yard of excavation had been on any job. As this was the very item needed to clinch the argument, the records were practically valueless for the matter in hand. It may be noted that the managers of the firm were of the two more surprised at this fact than was the writer.

These two "experiences" have been cited because of their force as examples illustrating the arguments of Mr. Howard in his paper printed elsewhere. Records are the

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Cost of Constructing a Reinforced Concrete Dam for Irrigation Work in Wyoming.*

The Corbett Diversion Dam was built by contract during the latter part of 1906, and the fore part of 1907 for the total contract price of \$66,750. This dam is located on the Shoshone River about eight miles below Cody, Wyo., and is a part of the irrigation structures pertaining to the Shoshone project. Water of the Shoshone River is stored in the Shoshone reservoir by means of the large Shoshone Dam located about eight miles above Cody, and is drawn off through an outlet tunnel into the river, where it travels for about 16 miles. The Corbett Dam serves to divert the water from the river through the Corbett Tunnel into the Garland Canal, thence

data relating thereto are tabulated below under the primary heading of distribution of cost and under the secondary headings of the class items of the schedule. Labor conditions were extremely bad during the entire construction period, but the contractor was provided with fairly efficient equipment. Laborers were paid at the rate of \$2.50 to \$3 per eight-hour day, carpenters at the rate of \$3 to \$4.50 and teams at the rate of \$2.50.

There was no suitable sand for concrete in the vicinity of the dam, and it was necessary to establish a crushing plant for manufacturing the same from cobblestones. The crusher and concrete mixer were located at a distance of about 400 ft. from the right abutment of the dam. The concrete was hauled from the mixer to central points on the dam by means of cars of ½

ITEMIZED COST OF REINFORCED CONCRETE DAM FOR IRRIGATION WORKS IN WYOMING.

Distribution of cost—	Excavation, class 1. 7,865 cu. yds.		Excavation, class 2. 2,681 cu. yds.		Excavation, class 3. 1,454 cu. yds.		Puddling. 1,712 cu. yds.		Reinforced concrete. 4,950 cu. yds.		Hauling and placing reinforcing steel. 319,352 lbs.		Hauling and placing cast iron. 39,385 lbs.	
	Total.	Unit.	Total.	Unit.	Total.	Unit.	Total.	Unit.	Total.	Unit.	Total.	Unit.	Total.	Unit.
Interest on investment.....	\$ 347.00	\$0.044	\$ 354.00	\$0.132	\$ 380.00	\$0.261	\$ 72.00	\$0.042	\$ 1,675.00	\$ 0.338	\$ 145.00	\$0.004	\$ 27.00	\$0.0007
Preparatory expense.....	420.00	.053	430.00	.168	482.00	.332	89.00	.052	2,068.00	.418	177.00	.0005	34.00	.0009
Plant depreciation.....	347.00	.044	354.00	.132	380.00	.261	72.00	.042	1,675.00	.338	145.00	.0004	27.00	.0007
Executive.....	1,137.00	.145	1,165.00	.484	1,246.00	.857	240.00	.140	5,553.00	1.122	473.00	.0013	9.00	.0023
Labor.....	7,466.63	.948	7,660.79	2.853	8,274.07	5.648	1,631.25	.953	32,831.54	6.632	2,582.06	.0084	620.07	.0164
Supplies.....	262.65	.035	262.62	.097	62.82	.181	.....	.....	4,950.70	1.000	.....	.....	.....	.....
Total contractor's cost.....	\$9,980.28	\$1.269	\$10,226.41	\$3.881	\$10,964.69	\$7.541	\$2,104.25	\$1.229	\$48,753.24	\$9.818	\$3,522.06	\$0.011	\$799.07	\$0.021
U. S. materials.....	8.28	.001	8.29	.004	8.28	.005	.....	.....	24,369.55	4.925	7,275.76	.022	5,974.67	.129
U. S. engineering.....	408.15	.052	495.00	.175	555.81	.383	44.63	.026	2,156.90	.436	321.55	.001	239.52	.005
Total actual cost.....	\$10,396.71	\$1.322	\$10,699.74	\$3.990	\$11,528.78	\$7.980	\$2,148.88	\$1.255	\$75,279.69	\$15.209	\$11,119.37	\$0.044	\$6,104.26	\$0.155

ammunition of the engineer and the contractor for future engagements and they must be carefully kept if they are to be ready for use when needed.

Correction.

Through an error in editing, the name of Mr. Clarence Mayer was omitted as author of the article "New Methods of Laying Duct and Building Manholes for Electric Transmission Lines With Figures of Comparative Costs," published in our issue of Aug. 19, 1908.

The port commissioners of Rangoon, Burma, have been authorized by the Indian Government to negotiate a loan of \$2,500,000, for the improving of the port of Rangoon and river training works.

The world's production of zinc spelter in 1907, according to the U. S. Geological Survey, was 813,812 short tons, against 775,871 tons in 1906. The United States was the country with a large increase, having advanced from 224,770 tons to 249,812 tons. Belgium produced in 1907 170,307 tons, and Silesia 152,611 tons, both slight increases.

onto the lands of the Shoshone project covered thereby. The Garland Canal has a capacity of 1,000 second-feet, and will ultimately water about 80,000 acres of land in the Shoshone Valley.

The Corbett Dam is of the reinforced concrete buttressed type, having a deck 30 ins. thick on the upper side with a slope of 1 to 1. This deck rests on buttresses 2 ft. thick, spaced 14 ft. on centers. The structure is founded on gravel and shale, and has a reinforced concrete platform 2 ft. thick resting on the foundation and extending from the deck wall down stream to a distance of about 40 ft. Beneath the deck of the dam and this platform are three cut-off walls running lengthwise of the dam and extending down into the shale. The total length of the dam between abutments is 400 ft., and extending from the right abutment of the dam to the bluff is an earth embankment about 450 ft. in length. At the left end of the dam are located the sluiceway and the headworks of the Corbett Tunnel.

Careful records of cost were kept during the construction of this structure, and the

cu. yd. capacity drawn by horses. At these central points the concrete was transferred to small hand carts, and thus conveyed to various local points on the dam.

The shore ends of the dam were constructed during ordinary stages of the river without diverting the river from its channel. For the portion of the dam in the channel of the river it was found necessary to construct a temporary dam from the end of the sluiceway wall diagonally across the river, thus diverting the entire low water flow of the river through the sluiceway.

The U. S. Civil Service Commission, Washington, D. C., will hold an examination on Sept. 9-10, to secure eligibles from which to make certification to fill a vacancy in the position of civil engineer and superintendent of construction, at \$1,500 a year, in the Quartermaster's Department at Large, New London, Conn., and vacancies requiring similar qualifications as they may occur in any branch of the service. Applications must be filed prior to closing hour on Aug. 31.

The present total mileage of the Intercolonial Ry. of Canada is 1,468.65 miles.

*Reprinted from the "Reclamation Record" for August, 1908.

Useful Tables for Estimating the Cost of Concrete and for Designing Reinforced Concrete Beams and Slabs.

Tables of cost and crushing strength of concrete mixtures when compiled from re-

provements, Chicago, Ill., from various and it is believed trustworthy sources. In this table the first column names the several kinds of structures in the order of the relative richness of mixture required. The cost column, while necessarily based on given constants, shows relative costs of

vantage of using not less than 1 1/2 per cent of steel for reinforcing.

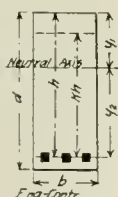
The State Department of Public Work of New York is now calling for bids on two contracts for Barge Canal work. One of these, Contract No. 20, involves the ex-

TABLE I.—QUANTITIES, COST AND STRENGTH OF CONCRETE.

Class of work Using the Different Proportions.	Ratio of Volume of.	—Materials for 1 cu. yd. Rammed Concrete.—										Crushing Strength and Cost of Various Classes Brick Work.							
		Broken Stone Screened to Unif'm Size.			Average Condit'n Broken Stone Dust Screened Out.			For Gravel or Mixed Stone & Gravel.			Ultimate Compressive Strength Stone Concrete 6-in Cubes 1 Month Old in lbs. per sq. in.		Ratio of strength of Concrete based on 1-2 1/2-5 Mix.	First Class in Cement Mortar \$24 lbs. sq. in. \$0.44 per cu. ft.					
Ornamental Castings.	Cement.....	Sand.....	Stone.....	Cem.—Bbl.....	Sand—Cu. yd..	Stone—Cu. yd.	Cem.—Bbl.....	Sand—Cu. yd..	Stone—Cu. yd.	Cem.—Bbl.....		Sand—Cu. yd..			Gravel—Cu. yd.	Av. Volume of a Batch in place using 1 Bbl. Cem. (3.8 cu. ft.)	Cost per cu. ft. of Concrete in place.	Broken Stone	Clean Gravel.	Concrete 6-in Cubes 1 Month Old in lbs. per sq. in.	Ratio of strength of Concrete based on 1-2 1/2-5 Mix.	Good Brick in Cement Mortar $24 lbs. sq. in. $0.25 per cu. ft.
Columns.	1	1 1/2	1	...	...	...	...	...	...	...	...	...	6.8 cu. ft.	\$0.37	\$0.34	5340	1.24	Cement Mortar 486 lbs. sq. in. \$0.25 per cu. ft.	
Beams.	1	1	2	2.85	.40	.80	2.73	.38	.77	2.62	.37	.74	9.7 cu. ft.	0.314	0.274	4000	1.73	Ordinary Brick in Lime Mortar 347 lbs. sq. in. \$0.26 per cu. ft.	
Floors.	1	1 1/2	3	2.09	.44	.88	2.00	.42	.84	1.91	.40	.81	13.0 cu. ft.	0.283	0.237	3200	1.39	—	
Walks.	1	2	4	1.65	.46	.93	1.57	.44	.88	1.50	.42	.84	16.5 cu. ft.	0.264	0.214	2700	1.17	—	
Walls.	1	2 1/2	5	1.37	.48	.96	1.30	.46	.92	1.24	.44	.87	20.0 cu. ft.	0.246	0.195	2300	1.00	—	
Ret. Walls	1	3	6	1.16	.49	.98	1.11	.47	.94	1.05	.44	.89	24.0 cu. ft.	0.230	0.179	2000	.87	—	
Foundations.	1	4	8	0.90	.51	1.01	0.85	.48	.96	0.81	.46	.91	31.0 cu. ft.	0.210	0.160	1625	.70	—	
Dams.	1	5	10	0.73	.52	1.03	0.69	.49	.97	0.66	.46	.93	38.0 cu. ft.	0.200	0.149	1400	.61	—	
Mass Concrete.	1	6	12	0.62	.52	1.04	0.58	.49	.98	0.56	.47	.94	46.0 cu. ft.	0.192	0.141	1250	.54	1,000 Brick = 40 cu. ft. when laid.	

NOTES: Water required = 15% to 25% (by volume of concrete). Strength of Concrete is directly proportional to amount of Cement used. Machine mixing averages (on strength tests of product) 20% better than hand mixing. Costs based on following constants: Cement, delivered, per bbl. (net), \$1.75; Sand, delivered, per cu. yd., \$1.20; Broken Stone, delivered, per cu. yd., \$1.90; Gravel, delivered, per cu. yd., \$1.15; Labor, per cu. yd., \$1.62. Average Costs, Machine Mixing, \$1.00 per cu. yd. in place. Hand Mixing, \$1.50 per cu. yd. in place. Safe stress on Concrete: Working stress on beam, ultimate, 4.5; working stress in columns, ultimate, 6. Concrete weighs 140 lbs. per cu. ft.

liable data, have a very useful purpose in figuring on concrete work. In our issue of Feb. 19, 1908, we published a table of this character long used by a prominent East-



ern contractor. Another table of similar scope is given here (Table I). This table has been compiled by Mr. H. J. Fixmer, Assistant Engineer, Board of Local Im-

provements, Chicago, Ill., from various and it is believed trustworthy sources. In this table the first column names the several kinds of structures in the order of the relative richness of mixture required. The cost column, while necessarily based on given constants, shows relative costs of

different mixtures which are fairly true for all cases. These costs, in connection with the ratio of strength figures, show almost at a glance the economy of the selected mixtures. The last column shows the inferiority of brick construction when compared with concrete construction. Table II. is used in designing slabs and girders. Attention is called to the fact that the value h is used and that the value $d-h$ is the selected thickness of the fireproofing only. In other words the depth of the beam is the value h plus the thickness required for fireproofing. The value $fc=500$ lbs.—is practically the universal building code allowance. The value fs of course varies with the percentage of steel used. A little study of the table shows the ad-

penditure of about \$4,173,900 and calls for the dredging of the channel in the Mohawk River between Rexford Flats and Little Falls.

A very heavy rainfall occurred Aug. 7 at Bohio, Isthmian canal zone. Between 2:30 o'clock in the afternoon and 5:30 o'clock, 7.62 ins. fell, and the total for the storm, which began about noon and lasted almost continuously until 9:45 p. m., was 8.82 ins. The maximum for ten minutes was 1.15 ins., and the maximum for one hour was 4.50 ins.

During 1907 4,267 vessels with a tonnage of 214,728,434 passed through the Suez canal.

TABLE II.—REINFORCED CONCRETE BEAM AND SLAB TABLE.

(Table based on a 1-2 1/2-5 mix Concrete (1 month old), wherein $\frac{Es}{Ec} = \frac{30,000,000}{2,500,000} = 12$, $fc=500$ lbs. per sq. in. $fs = \frac{1}{3}$ (or $\frac{1}{4}$) Elastic Limit of Steel in lbs. per sq. in.)

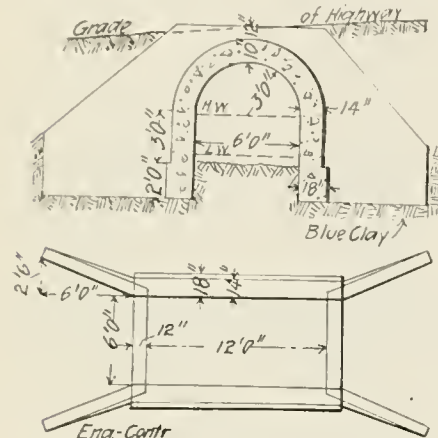
fc = Unit Work'g Stress in Concrete.	fs = Unit Work'g Stress in Steel.	Y1.	Y2.	K.	Mo = Resisting Moment in inch lbs.	As = Area of Steel in sq. ins.	P = Per cent of Steel.	Reinforcing.	
								Diam. of Bars.	Area in sq. ins. Round.
500	20,000	0.23	0.77	0.93	55.8bh ²	.0030bh	30/100%	3/4 in.	.017
500	16,000	0.27	0.73	0.91	61.15bh ²	.0042bh	42/100%	1/2 in.	.067
500	14,000	0.30	0.70	0.90	68.07bh ²	.0054bh	54/100%	3/8 in.	.11
500	12,000	0.33	0.67	0.89	73.68bh ²	.0069bh	69/100%	1/2 in.	.25
500	10,000	0.37	0.63	0.87	80.05bh ²	.0092bh	92/100%	5/8 in.	.39
500	8,000	0.43	0.57	0.85	91.12bh ²	.0134bh	134/100%	3/4 in.	.60
500	6,000	0.50	0.50	0.83	103.6bh ²	.0208bh	208/100%	7/8 in.	.765
500	4,000	0.60	0.40	0.80	120.0bh ²	.0375bh	375/100%	1 in.	1.00

NOTES: Mo = Resisting Moment, = $Kh As fs$. $d-h$ = (for fire proofing) = 3/4 in. to 2 1/2 in. B. M. = Bending Moment For Uniform Load = $\frac{Wl^2}{8}$. W = Total Weight incl. w't. of Concrete. l = Span in ins. Working Stress, Shear, = 75 lbs. per sq. inch. Working Stress Adhesion, = 75 lbs. per sq. inch. 1 34/100% Steel (32,000/4 = 8,000 lbs. stress) or greater per cent gives most economical reinf.

REMARKS: Steel weighs 3 1/2 times the weight of Concrete. Steel at 2 1/2¢ per lb. costs (av.) 50 times cost of Concrete. Sectional area of bars in sq. ins. times 3.4 gives the weight of bars in lbs. per linear foot. Cost of placing Steel ranges from 1/4¢ to 1/2¢ per lb. Use $fc=500$ lbs. and 1-2 1/2-5 mix for ordinary work. Use richer mix when using factor of safety greater than 4.

Cost of Constructing a Small Concrete Culvert for a Highway.

The following figures rearranged from the "Canadian Engineer" give the cost of constructing a 6-ft. arch culvert of concrete for a rural highway. The design of the culvert is shown by the sketch plan and section. It replaced a timber bridge with an 8-ft. opening so that very little excavation was necessary. The cost was also reduced by the fact that the form lumber had been used previously and was used subsequently on similar work, and only the lumber actually wasted was charged to this particular job. There were 15 cu. yds. of



Plan and Section of Culvert.

concrete in the culvert. The concrete was machine mixed and wheeled 50 ft. to the forms. The costs were as follows:

	Per	
Excavation:	Total. Cu. Yd.	
1 man 1 day at \$1.75.....	\$ 1.75	\$0.117
Concrete materials:		
17 bbs. cement at \$2.50.....	\$ 42.50	\$2.833
17 cu. yds. gravel at \$1.....	17.00	1.133
Totals	\$ 59.50	\$3.966
Mixing and placing concrete:		
2 men 3½ days at \$1.75....	\$ 12.25	\$0.817
Rent of mixer 4 days at \$3.	12.00	0.800
Moving mixer to work.....	2.50	0.166
Totals	\$ 26.75	\$1.783
Forms and centers:		
200 ft. B. M. lumber at \$20.\$	4.00	\$0.266
Hauling lumber to work....	3.00	0.200
1 man 4 days at \$2.50, making	10.00	0.666
Totals	\$ 17.00	\$1.134
Grand totals.....	\$105.00	\$7.000

The municipal authorities of Zittau, Saxony, have been employing electricity for the destruction of nun-moths, which were ravaging the trees of their foliage. A high-power arc and reflector were used to produce a beam of light which attracted the moths, and when they got near the reflector they were drawn by the suction of a draft-fan into a chamber, where they were destroyed.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Comments on Some Records of Hauling Earth in Cars and Dumping with Plows.

Few engineers and contractors seem to realize the importance and the cost of dumping excavated material. Evidence confirmatory of this statement is found in the fact that engineers and contractors are continually having this class of work done by hand, not realizing that it is a very costly operation.

During the past month or two we have published a number of articles containing detail costs of excavating, and the cost of dumping the material has run from 1 to 10 cts. per cu. yd., being from about 10 to 30 per cent of the total cost of excavating, transporting and dumping the material. These costs have not included lost team and train time on the dumps, such costs having been included in the cost of transporting the material, but the dumping costs have included only labor of dumping and supplies and materials, such as temporary trestles, etc., used on the dump.

One reason the dumping of material has been ignored has been that gravity plays a prominent part in the work, and the popular idea is that work done by gravity is cheap. Then, too, in most cases where cost records are kept, all the items are bunched together, and it has not been possible to analyze the various details of the work. This journal, during the past few years, has done much in this line by collecting and publishing records in which the costs of the various details of the work have been segregated, thus calling attention to the need of reducing the costs of many details of the work. In this article we purpose giving some records of hauling and dumping on the Panama Canal as given in the Canal Record, supplemented by data gathered from the reports of the Isthmian Canal Commission.

Plows for unloading or dumping earth from flat cars have been in use for many years, but very few records of work done by them have appeared in print.

The canal commission has in use 27 such plows. These plows are made of three general designs, known as right hand, center and left hand plows. Naturally right and left hand plows dump the material on the right and left hand sides of the cars respectively, while the center plows dump the material on both sides of the cars.

The Lidgerwood Mfg. Co. makes what is known as a Rapid Unloader, which consists of a large hoisting engine mounted on the car next to the locomotive and taking steam from the latter. The hoisting engine op-

erates the cable that pulls the plow along the cars, as it unloads the earth. When this Rapid Unloader is not used, the locomotive is uncoupled from the train, and, while the cars are standing still, the locomotive, by pulling away from the cars, drags the plow along. Naturally the Rapid Unloader effects many savings over the locomotive, and gives a wider range of work, as well as operating the plow to much greater advantage.

On the Panama canal 18 of these unloaders are used in dumping dirt from flat cars. The flat cars used on the canal have side boards on one side, while the other side is open. This admits of using only right or left hand plows. From the Culebra cut to the Tabernilla dump trains of 17 cars are used to carry the earth and rock. These trains are loaded under the shovel and carried directly to the dump without being made up a second time, the distance being 16 miles. On June 23, 54 of these trains were unloaded by four unloaders in 8 hrs., handling a total of 17,280 cu. yds. This is at the rate of 4,320 cu. yds. per machine, being 540 cu. yds. handled per hour for each machine. This is the largest single day's work of this character that has been done on the canal.

The 17,280 cu. yds. were hauled by 864 cars, thus making an average load of 20 cu. yds. per flat car. The train is made up of 17 cars, but we surmise that one car in the train carries the plow, leaving but 16 cars for carrying earth. The car with the unloader on it is left at the dump and picked up as each train arrives there.

We have no means of knowing what is the rated capacity of these cars, as there has been no published statement of this, but the 20 cu. yds. is considered place measurement, thus making the 17,280 cu. yds. given above place measurement.

The canal commission is using four styles and sizes of cars: The large Lidgerwood flats, 20-yd. Western side dumps, 12-yd. Western and Oliver side dumps and the old French 6-yd. dump cars. The Culebra or Central division in order to reduce their loads to place measurement allow the following loads per car:

- Lidgerwood Flats, 20 cu. yds.
- 20-yd. Western Dumps, 17 cu. yds.
- 12-yd. Western and Oliver Dumps, 10 cu. yds.
- 6-yd. French Dumps, 5 cu. yds.

From the last three loads it will be seen that the place measurement load is from 83½ to 85 per cent of the rated capacity of the car. Allowing this same 83 per cent for the flat cars their rated capacity would

be 24 cu. yds. This is a very large car and 20 cu. yds. of place measurement on such a car, with one side off the car, is a large load. In fact all the loads allowed for the cars by the engineering department of the commission seem large. The ordinary flat car without sides carries a large load when it has 10 cu. yds. place measurement, and a flat car with two sides and swing doors is well loaded when it carries 20 cu. yds. place measurement.

Editors of this journal, who have kept such records, have found that the place measurement of car loads for large cars run from 70 to 75 per cent of the rated capacity of the cars, when the cars are well loaded; that is, heaping. See Engineering Contracting Aug. 5, 1908, page 83. For records showing the capacity of dump carts and small cars for earth and rock, see Gillette's Rock Excavation—Methods and Cost, pp. 180 and 226. It would appear from such records that the figures used at Panama are about 10 per cent too large. The trains hauling earth from Culebra to the Tabernilla dump, a haul of 16 miles, are, when working at their best, making 3 round trips a day. This means that 96 miles are traveled each day, and 48 cars are loaded, the working day being 8 hours. This is a good record, although many contractors working 10 hours have made from 90 to 100 miles a day with standard gage outfit, the length of haul, though, is seldom as long as 16 miles. With shorter hauls, more time is consumed in loading, with the result that it is harder to make the mileage. With narrow gage outfits less mileage is made. Freight trains, other than carded trains, seldom make more than 100 miles in a day. With a good system of operating the dirt trains, we can see no reason why each train should not make 100 miles per day at Panama with hauls from 9 to 16 miles long.

One train made up of 12-yd. Western dump cars hauling from Culebra to Mamei dump, nine miles, loaded, hauled and dumped 294 cars in 6 days, being 3,528 cu. yds. loose measurement or 2,940 cu. yds. place measurement. This meant 490 cu. yds. place measurement handled by this train a day. This is the highest record made by a train using these cars and running to this dump. With a train made up of 12 cars, this meant 4 round trips per day, or a distance of 72 miles traveled in 8 hrs. by the train. The efficiency of the larger cars is shown by the fact that a train of 24 yd. flat cars, making a haul of 16 miles, carried to the dump 960 cu. yds. place measurement per day, as compared to 490 cu. yds. place measurement with 12-yd. cars on a nine mile haul.

The study of the size of car to use in earth and rock excavation is an interesting and important one, and, inasmuch as four sizes of cars are being used at Panama, it should be possible for the engineers in charge to gather and publish much valuable information on the subject, also the cost of dumping the material from the various

The Pressure of Earth Filling on Bracing in Trenches.*

By MILO K. KETCHUM, C. E.

All theoretical investigations of the pressures of earth are based on the assumption of a granular mass without cohesion, the particles being held together by friction of the particles on each other, the mass being of indefinite extent. Where cohesion is sufficient to hold the mass in position, the theoretical formulas do not apply, and where the mass does not extend indefinitely back from the surface, as in a grain bin, the general formulas must be modified. The writer offers the following solution of the problem of earth pressures on the sheeting of deep trenches:

If a trench be excavated in earth in which there is cohesion, the sides will stand vertically until the soil loses its cohesive power, or, if the trench is excavated rapidly, a depth BD , Fig. 1, is reached where the weight of the earth will overcome the cohesion and the friction, and

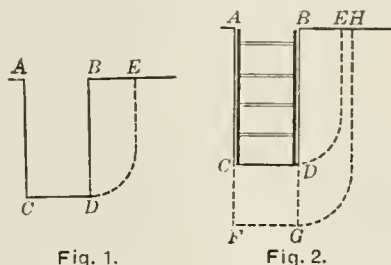


Fig. 1.

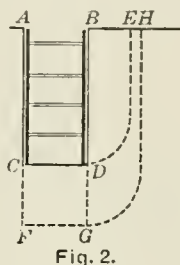


Fig. 2.

the earth will cave in. When the slip occurs the cohesion is practically destroyed in the mass BDE , and if the factor of cohesion is known, the curve DE can be calculated.†

Now, if sheeting be placed in the trench and properly braced, the mass BDE will

be held in place, and there will be no active pressure on the sheeting until the depth, BG , Fig. 2, is reached where the weight of the mass BGH is sufficient to overcome the cohesion and the initial stresses in the bracing. It will be found that BH is not much larger than BE which shows that the mass BED is held up mainly by the friction of the earth on the sheeting BD and the surface HG .

The pressure on the sheeting in a trench

$$\tan x = \sqrt{\frac{2h}{d} \times \frac{1 + \mu^2}{\mu + \mu'} + \frac{1 + \mu^2}{\mu + \mu'} \times \frac{1 - \mu\mu'}{\mu + \mu'} - \frac{1 - \mu\mu'}{\mu + \mu'}} \quad (3)$$

and

$$P = w \times \frac{d}{2} \times (2h - d \tan x) \times \frac{\tan x - \mu}{1 - \mu\mu' + (\mu + \mu') \tan x} \quad (4)$$

in a cohesive soil is then seen to be due to the material between the sheeting and the surface HG . The problem of the cal-

culation of the stresses is then essentially the same as the calculation of the stresses of granular material in a deep bin.

In Figs. 3 and 4, CA is the sheeting and DB is the surface of cohesive rupture, assumed to be vertical.

Let W be the weight of the wedge CAE , one foot thick; P be the total pressure on wall; R be the reaction of the material

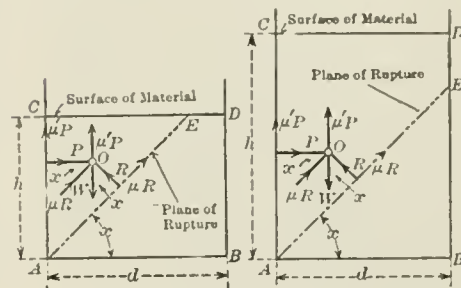


Fig. 3.

below the plane of rupture AE ; x be the angle of rupture; μ be the coefficient of internal friction of earth; μ' be the coefficient of friction of earth and the sheeting CA ; O be the center of gravity of the wedge CAE ; and w be the weight of a unit of the filling.

In Fig. 3 the material in the wedge CAE slides on the plane of rupture AE , the weight of the wedge, W , is held in equilibrium by the pressure P , the reaction R , on the plane AE , the friction μP on the wall, and μR on the plane of rupture, AE .

Now resolving the forces parallel and perpendicular to the plane of rupture, AE , and solving for a maximum value of the angle of rupture, x we have**

$$\tan x = \mu + \sqrt{\mu \times \frac{1 + \mu^2}{\mu + \mu'}} \quad (1)$$

$$P = w \times \frac{h^2}{2 \tan x} \times \frac{\tan x - \mu}{1 - \mu\mu' + (\mu + \mu') \tan x} \quad (2)$$

Equations (1) and (2) give the pressure on the side CA as long as the plane of rupture, AE , cuts the surface of the material.

In Fig. 4 the plane of rupture, AE , cuts the side DE , and equations (1) and (2) will not apply.

Equating the forces parallel and perpendicular to the plane of rupture, AE , in Fig. 4, and solving for a maximum value of the angle of rupture, x , we have*

It will be seen in equations (1), (2), (3) and (4) that the pressures vary as h/d . These equations are complicated but special solutions may be made as follows:

In Fig. 5 the writer has plotted values of P/d^2 for different values of h/d for "earth" weighing 100 lbs. per cu. ft., angle of in-

*Reprinted from the Transactions American Society of Civil Engineers, Vol. LX, 1908.

†Merriman's Retaining Walls, page 16.

**For the derivation of formulas (1) to (4), inclusive, see the writer's book, "The Design of Walls, Bin and Grain Elevators."

ternal friction $\phi = 31^\circ$, $\mu = 0.6$, and angle of friction of earth on the sides $\phi' = 31^\circ$, $\mu' = 0.6$, P being the total pressure on the wall one foot long for the depth h . To calculate the pressure on a square foot at a depth of 50 ft., calculate P for $h = 49\frac{1}{2}$ ft., and P for $h = 50\frac{1}{2}$ ft., and the difference between the two values of P will be the pressure on the square foot at the required depth. In this manner the writer has calculated, in Fig. 6, the pressures per square inch for different depths for earth where the break back of the wall is 10, 20 and 30 ft. Pressures for other widths may be interpolated from the diagram. As an example, the pressure for a width of 5 ft. and a depth of 20 ft. is one-half the pressure for a width of 10 ft. and a depth of 40 ft.

For example, if the ground breaks 10 ft. back from the sheeting the pressure at the depth of 50 ft. will be 4 lbs. per sq. in., or 576 lbs. per sq. ft. Of course, this pressure will not be developed until the excavation has extended far enough below this depth to destroy the cohesion. With a width of 5 ft. and a depth of 50 ft., the pressure will be one-half the pressure with a break at 10 ft. at a depth of 100 ft., or one-half of $4\frac{1}{2}$ or $2\frac{1}{4}$ lbs. per sq. in., or 360 lbs. per sq. ft.

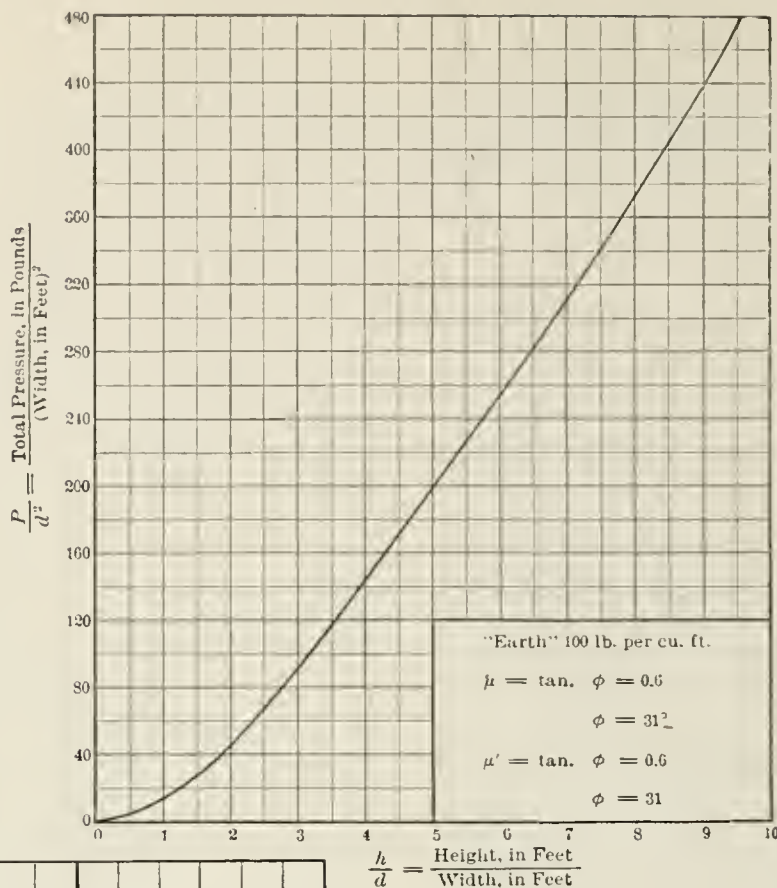


Fig. 5.

The pressure on the mass below the given depth will be found by subtracting the weight supported by the walls from the total weight. For a break back of the wall of 5 ft. and a depth of 40 ft., the pressure on the side, from Fig. 5, will be $P = 375 \times 25 = 9,375$ lbs., or 19,750 lbs. on both sides. The weight of a section of earth one foot long will be $5 \times 40 \times 100 = 20,000$ lbs. The loads supported by the sides will be $19,750 \times 0.6 = 11,850$ lbs.; making the pressure on the bottom $= 20,000$ lbs. $- 11,850$ lbs. $= 8,150$ lbs.

In the practical application of this solution, diagrams, such as given in Figs. 5 and 6, should be constructed for the weight, w , angle of repose, ϕ , and angle of friction, ϕ' , of the filling on the sheeting.

The center of pressure will be at approximately one-half the depth for deep trenches. If quicksand is encountered the pressure will be more nearly that given by the horizontal projection of the break is a curve, but for a long trench the break will be approximately a straight line.

The solution above gives results consistent with observations and is based upon reasonable assumptions. Of course it cannot be expected that any solution of the problem will give results that are more accurate than the data. It is the opinion of the writer that if engineers were more familiar with the theoretical investigations of retaining walls, there would be less objections to such investigations.

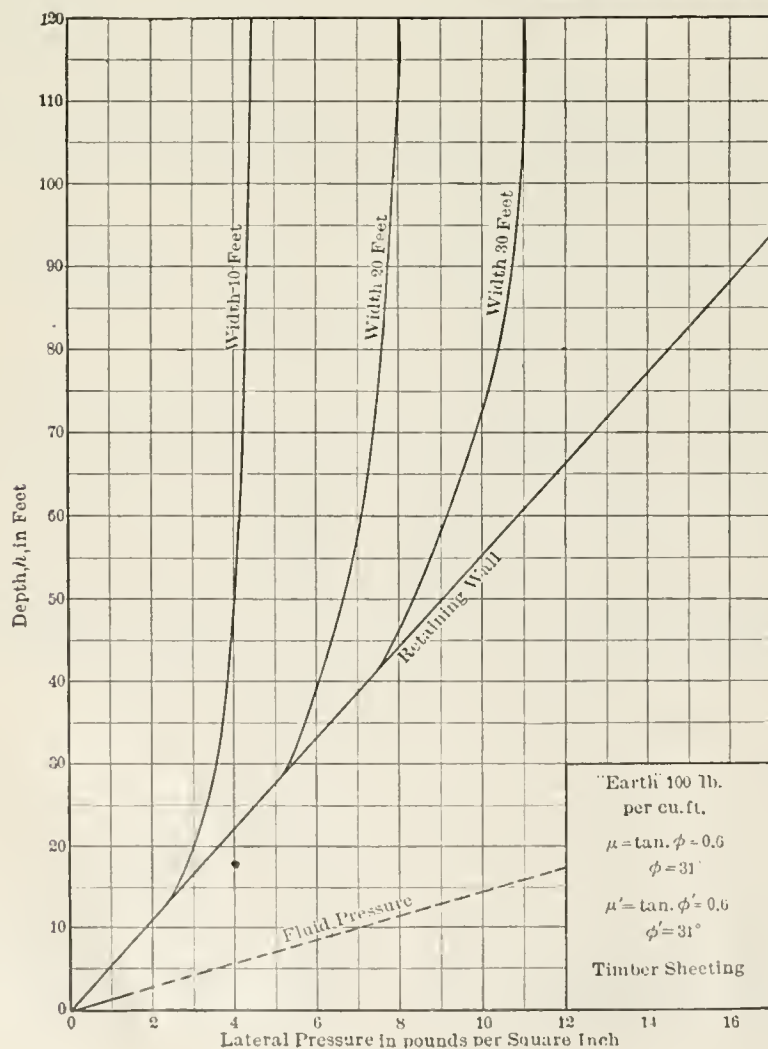


Fig. 6.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Method of Mixing and Laying Tar-Macadam for Streets and Main Roads.*

BY JOHN S. BROFIE, M. INST. C. E.

The first essential condition for a successful tar macadam road is a dry and strong foundation. The author's practice is to underdrain where necessary the site of the proposed tar macadam road (whether for an entirely new road or for replacing old pavement on an existing road) with open jointed 3-in. tile drains, connected to the surface water gullies. Where a road is on sandy or light porous subsoil, with sufficient natural drainage, underdrainage is, of course, unnecessary. The underbed is then formed to proper levels and contour by means of a transverse sectional gauge, and is thoroughly rolled and consolidated under a steam roller, any inequalities being made up with sand filling.

On the underbed prepared as above the foundation proper is then laid. It consists of rubble (grit, limestone or granite, or even good hard clinker, as may be most economical) 9 ins. to 12 ins. in length, 3 ins. to 6 ins. in width, and 7 ins. to 9 ins. in depth, laid on edge lengthwise across the road. The interstices are then filled up with similar stone broken to 2½-in. to 3½-in. gauge, and the whole foundation is then rolled, by a 10-ton steam road roller, to the correct cross-sectional gauge or template above referred to, until the surface of the foundation presents the appearance of a well rolled macadam road. On the foundation, prepared as stated above, the tar macadam, when mixed, is laid.

The materials forming tar macadam are (a) suitable hard stone or slag to resist the wearing action of the traffic, and (b) a matrix impervious to moisture and sufficiently elastic and tough to bind the harder material together. The author has used extensively granite, blast furnace slag, and many varieties of limestone as traffic resisting materials, and has found most uniform satisfaction to follow from the use of a suitable gray or light colored limestone. Granite is, chiefly owing to its non-porous nature, a somewhat uncertain material to use in connection with tar macadam, although undoubtedly good result have been obtained from its use in certain instances.

Slag is open to objection chiefly because of the impossibility of procuring a uniform quality, however carefully the selection may be made. So many elements of uncertainty arise from the use of different kinds of iron ore smelted, the nature of the limestone used as flux, and of the coke as fuel,

that the slag is left to come out as it may, since its quality is no concern of the iron smelter, and is merely a kind of haphazard result. The proof of this is seen in the uneven way in which a tar asphalt made of slag usually wears.

The stone, having been selected, must be broken to three sizes—viz.: 2¼ ins., 1¼ ins. and ¾ in. to ½ in.—and all dust, dirt and smaller material most carefully screened out of it. The matrix used by the author consists of suitable hard pitch properly tempered by impure carbolic acid, or dead oil, commonly known in the trade as "creosote" oil. Both of these substances are derived from the distillation of coal tar, itself a most complex substance, and hence the necessity for chemical tests of both pitch and oil in order to make sure that the light oils (benzoline, naphthalene, etc.) have been properly removed in the process of distillation.

They are mixed in the proportion of about 1 gallon of oil to 40 lbs. of pitch, but this proportion may often require modifying, as the pitch and the oil vary in quality and the mixture should be tested when boiling by samples being taken out of the boiler and cooled to a temperature of about 60 degs. Fahr., and tested for elongation of about 30 ins., and bending double without fracture.

The stones having been properly dried, so as to expel all the moisture, but not to injure the stone, the various sizes of stone are then separately covered with the asphalt composition while boiling hot, to which a small quantity of dry sand and lime is added in the buckets after it leaves the boiler, and stirred up by hand. There are several mechanical mixers on hot plates now being used, but the author prefers hand mixing so as to guarantee that, while the entire surface of every stone is coated with the composition, there is not an excessive amount of the liquid resulting in what is known among the workmen as making the asphalt "too fat." The asphalt having been mixed as above, is stored in separate heaps of various gauges, under cover, ready for use, but is distinctly improved by remaining in store exposed to the air, but protected from the rain, for a few days before it is laid in position.

The asphalt macadam should be laid on the foundation prepared as above described, in favorable atmospheric conditions. No asphalt macadam should be laid when rain is falling, nor immediately after rain has fallen, until the surface of the foundation is reasonably dry. The prepared material should be spread in successive layers, the largest gauge material in the bottom, the 1¼-in. gauge material above the largest

size stone, and the finest gauge material on the top. An allowance should be made of from 20 to 25 per cent more depth than the ultimate depth aimed at after rolling. Thus for a finished depth of 5 ins. of tar macadam at least 6 ins. in depth should be spread. Also the thickness of the intermediate top layers should not vary whatever the thickness aimed at, the variation being all in the bottom layer of large gauge stones.

All the layers having been put on, rolling with a steam road roller of from 10 to 15 tons, on a wheel base of 6 ft., should be started at once, before it has received any moisture or dust. The roller wheels should be properly cleaned from all dirt before they are allowed on to the asphalt. The rolling should be continued until the rollers have passed at least twenty times over the entire surface of the road. No traffic should be allowed on the road until at least 48 hours have elapsed after rolling is completed, so as to give the tar macadam sufficient time to harden.

The use of tar macadam for forming the surface of roads and streets must be confined within certain limitations, as follows: (1) Not suitable for gradients steeper than 1 in 21 (½ in. in a foot), by reason of its slipperiness after wearing smooth. (2) Not suitable for heavy traffic. In any road, whether a street or main road, where the traffic exceeds an average of more than 100 tons per yard of width of roadway per diem, tar macadam will be found to be more expensive to maintain than wood paving or even rock asphalt. (3) On the other hand, for purely residential streets, whether front or back, where local traffic only or a through traffic limited in amount to the extent indicated above is expected a tar macadam road surface will give unqualified satisfaction as being (a) impervious to moisture and therefore always clean and free from dust and slops; (b) practically noiseless; (c) the most economical roadway at present known, considering its advantages.

Work will probably be started this fall on the new building at Union College, Schenectady, N. Y., for the civil engineering department. The building will be three stories in height, 136 ft. x 66 ft., and will cost about \$100,000.

From the time the Americans began a systematic investigation on the Isthmus of Panama in 1904, up to July 1, 1908, 3612 miles of borings were made to determine the geological structure along the line of the Canal, states the Canal Record. A hole has been sunk at every kilometer between Gatun and Pedro Miguel, and extensive borings have been made on the sites of the locks at Gatun, Miraflores, and Pedro Miguel, and at the abandoned lock site at Sosa. In Gatun and vicinity 79,511 ft. of borings have been made, and on the sites of the Pacific locks and dams the borings amount to 20,017 ft.

* Abstract of a paper read before the Conference of Engineers and Surveyors at the 24th Congress of the Royal Sanitary Institute of Great Britain.

A Large Sheet Piling Job, With a New Type of Steel Sheet Piling.

The accompanying cuts show the character of the steel sheet piling being used in the construction of the cofferdam for the new government ship dock in Black Rock Harbor, at Buffalo, N. Y. This lock when completed will be one of the largest in the world and the cofferdam construction requires 7,000 tons of steel sheeting. This cofferdam is 947 ft. long, 245 ft. wide outside dimensions at one end and 260 ft. at the other end, and requires lengths of 44 ft. to 50 ft. of piling. The wall of the cofferdam is made of two lines of piling 30 ft. apart, with division pockets at 30-ft. intervals, forming 30-ft. square pockets. Later these pockets will be filled with



Fig. 1.

clay to form the solid wall of the cofferdam.

The steel sheeting for the cofferdam is a special rolled one-section steel sheet pile recently put on the market by the Lackawanna Steel Co., Buffalo, N. Y.

The cuts represent clearly the form of the piling as rolled, and it will be noted that in this piling the flanges on the same side of the web are similar in design. The shorter flanges are hook shaped and engage with the corresponding hooked flange of the adjacent section. The longer flanges are shaped as shown to form a guard around the hook of the adjacent section. When the piling is driven the hooked flanges prevent longitudinal displacement, while the guard flanges prevent lateral displacement, and assist to prevent longitudinal displacement of the sections



Fig. 2.

The joint has three points of bearing which produce a positive and double interlock, firm and close, offering in a built up wall a rigid resistance to withstand the strain to which such a wall is subjected, particularly the longitudinal strain and the side or buckling strains. At the same time this interlock, with a bearing on both sides of the web, is such as to hold the piling in line while being driven, and to form a straight wall.

In the development of this bar special attention was given to the design of the flanges which form the interlock to secure for this joint the maximum strength against pulling apart while being driven, and at the same time to produce a form which should be simple, interlock perfect-

ly, and have the material so distributed as to give the largest radius of gyration, and correspondingly high strength.

The illustrations show the adopted sections and before placing them on the market an experimental cofferdam was driven with 32-ft. lengths of 12 $\frac{3}{4}$ -in. sheet piling. The material enclosed was subsequently excavated in order to ascertain the condition of the piling after driving, and to determine its efficiency as a protection against leakage. The result of this experiment proved that the interlock was perfect, and that the joints were practically water tight. A series of tests was also conducted to determine the strength of the interlock, and the average of these tests shows that with two 12 $\frac{3}{4}$ -in. sections interlocked the joint has in tension a value of 9,700 lbs. per linear inch of bar.

One feature of this bar is the ability to turn various angles and still maintain a perfect interlock, the shape of the interlocking flanges and hooks permitting a change in a direction with a line of piling in case of the encountering of bowlders, etc.

A second feature is that when driven in ordinary soil, such as clay and quicksand, enough of the soil works into the joints to make them practically water tight. If driven in clear water the usual methods of packing, if necessary, may be employed to produce a water tight joint.

The table below shows the standard weights and widths of sections rolled.

Thick- ness of web, ins.	Weight per sq. ft. of wall, lbs.	Distance C. to C. of joints ins.	Weight per lin. ft., lbs.	Width of joint over all, ins.
$\frac{1}{2}$	40.00	12 $\frac{3}{4}$	42.500	3 45/64
$\frac{3}{8}$	35.00	12 $\frac{3}{4}$	37.187	3 45/64
$\frac{1}{4}$	19.70	7	11.500	1 53/64

An ordinary pile driver is used, the head of the piling being fitted with an iron cap having a wooden cushion interposed between the iron cap and the hammer of the pile driver. In driving, satisfactory results have been obtained in keeping the vertical alignment of the bar. This is an important point, especially where a long well is driven and long lengths are used. In the closing of rectangular pockets the vertical alignment must be true in order that the closing pile will drive freely for its full length and not strain the interlock.

Fabricated corners are formed by fitting the edges of two half sections at the desired angle by means of structural steel angles. Junction members for cross walls are made up of a full section, a half section and two angles riveted together. Both styles of fabricated corners are shown by Fig. 2.

The Argentine Government has granted a concession to the Southern Railway Co. for the construction of nine branches and extensions of the total aggregate length of 826.42 miles, the most important, and one of those which is required to be first completed, being the extension of the Neuquen line to the Chilean frontier in the Cordillera.

The Importance of Records in Engineering Work.*

BY E. E. HOWARD,†

As engineering has to do with all branches of science and business, there are records to make of many different kinds. When an engineer prepares a design, as a banker he has records of money; as a merchant records of prices; as a bookkeeper records of costs; as a railroader records of tariffs; as a producer records of materials; as a manufacturer records of manufactures; as a lawyer records of law; as an artist records of eternal fitness; as a historian records of achievements; and as a poet records of his own imagination.

Engineering is not wild guessing; it is materialized, systematized, scientific imagining. In addition to being able to imagine what may be done, an engineer must have the records of what has been done, for only so can such imagining be scientifically economical. It would be a sad thing if each inventor had to go back to the beginning and repeat all the work of his predecessors.

My desire is to outline something of the records an engineer may be interested in, from perhaps a slightly different point of view than the reader has heretofore had. Many of the articles written on records consists of a bewildering number of examples of "forms used," leaving little coherent impression of the principles of record keeping. So many, so universal are the records to be made by the engineer, so constantly does he make them, and so wide are the ramifications that the work assumes that I can but direct attention to a general view of the subject, with a few illustrations. If you determine in your own mind the necessity and importance of this part of your work, your own ingenuity will develop the details.

Take, for example, a single structure from its inception to its completion. Assume it is a bridge. Somebody calls on the engineer to find out about building the structure, and the records begin. Letters are the first record. Then comes examination of the site, and investigation of bridges in a similar position. The preliminary report, a preliminary estimate of some sort, more letters, record of decision to build, surveys and borings with records, designs with records, specifications, drawings (records themselves), records of contracts, records of construction, records of field work, monthly estimates, records of acceptance, final record of completed structure—and you have left your engineer but little time but to make records.

It is not necessary for the young engineer to wait until he is called on to do some large work before he begins to make records in line with his chosen profession.

* Abstract of a paper in the Nebraska Blue Print, Vol. VII, 1908.

† With Waddell & Hedrick, consulting bridge engineer, Kansas City, Mo.

for he cannot proceed at all without this record making being thrust upon him.

Records are made for information, to preserve and convey thought. It is axiomatic to say that the record should be clear and plain. Records are for others as well as ourselves. If the thought is worth recording at all, it should be done in such fashion that it will convey information of a definite, intelligible sort. Here are two primary principles in record making:

(1) Records are for information.

(2) Paper is cheap.

Legibility is of first importance and should be attained, even though it is sometimes troublesome and expensive to do so. A commonplace subject which deserves attention is good hand writing. Writing is good if it is legible, whatever the style of penmanship, and no amount of ornate capitalization will atone for subject matter that cannot be easily read. Legible and orderly writing and figuring will advance the beginner in the estimation of every one with whom he has business. The time when a young engineer will have his own stenographer to take care of the legibility of his correspondence and records may be far distant; it is worthy of careful consideration that almost the first immediate connection the beginner will have with engineering will be making his part of certain records, and in that part hand writing and figuring will be the main factors. By "write" I do not mean literary composition, but merely the mechanical act of "tracing or inscribing symbols or ideographs."

Assuming then a serviceable, legible system of characters, here is another important principle of record making:

Systematic Arrangement.—An orderly allotment, a systematic arrangement of symbols, of characters, of words, terms, and of every detail of a record is essential to make that record complete. Accuracy is enhanced by a symmetrical, methodical apportionment and classification of data, while a record, however complete, if put together in a chaotic, ill arranged way, may lead to confusion; and the purpose of records is information, easy, accurate information.

The next important principle of record making is permanence. Of all deplorable, unsystematic habits of record making none is so bad as the making of desultory notes on loose sheets. Records should be kept in books or bound into books or some workable substitute. In some of the large drafting rooms of the structural shops of this country every mark of a pencil is required to be put down in a scratch book, each and every simple arithmetical operation, all so they can be found when the inevitable checking up comes. Too often it happens, if notes are made on such nondescript sheets, that they are misplaced or lost even before they are old; and one is forced to the undignified and annoying attitude of looking in the waste basket. Such a necessity in an engineering work is an indi-

cation of a lamentable lack of system, for information should be recorded so as to be available. To quote from two well known passages in literature, "Order is heaven's first law" and "What thou seest write in a book."

I have had to take a dozen small pieces of paper, torn off a little scratch pad, neither numbered nor marked by headings, and by successive alternative arrangements find from them the notes to determine sizes and elevations for the abutments of a bridge. It would be superhuman if such practices did not lead to errors and subsequent expense, for straightening out preventable errors.

As well as forcing some systematic arrangement, an additional advantage books have is that they are a step at least toward permanency. The necessity for permanency in many records that have to do with the expenditure of money, your own or some other man's, is so well recognized by good business men that every engineer should feel his own obligation to keep his own records in permanent shape.

All are familiar to some extent with the usual field books for engineer's records, and with forms for certain notes.

It is customary and in accord with every idea of order to have similar notes follow a set standard. But even these standards are oftentimes arranged and filled in in such a way that no one, even the maker, can after a lapse of time determine the meaning of the notes.

The field notes of a survey, of a pile driving outfit, of a force account, of anything, ought to contain all the information at hand in some sensible arrangement. For instance, a pile recorder may proceed to systematically designate the piles in the bents as Nos. 1, 2, 3, 4, and 5, and that may be clear in the notes, while you may search in vain whether he counted from the east, west, north, or south.

It not infrequently happens that the preliminary draft of notes of some kind must be made hurriedly or under circumstances which prevent a perfectly satisfactory final record being prepared at the time. The trouble and expense of doing some piece of preliminary work all over again may arise from losing all or a portion of a set of notes before they have been put in permanent shape. The first notes, too, should always be kept so that they can be referred to when necessary for confirmation.

Field notes should be concise, yet comprehensive. In making them everything should be put down that the taker thinks will be needed, and then all the things he thinks he will remember. They should contain all the facts of the matter in hand, yet they should be to the point and concise. But the conciseness must not be carried to the point of leaving out information which another person would need in checking over the notes, and it is from the standpoint of the other fellow that notes should generally be taken and kept. Faulty mem-

ories show themselves at the most inconvenient times, the employes in charge of certain branches of work change, and the only safe standard is to have an intelligent record that any intelligent man can comprehend. Two words need not be used where one would serve, but that one should not be omitted.

The value of comprehensiveness in records and the way to secure it was impressed upon my mind once on an inspection trip, when examining a number of bridges. The engineer whom I accompanied made the notes, while I did the climbing around, in addition to which I made my own notes. Each time I would be through and impatient to move on to the next bridge, and he would still be writing notes. When the time came for accounting and the notes were to be worked up, mine were decidedly lacking and his contained information which I had instinctively left to memory, and of course a fallible memory.

Comprehensiveness without discrimination is, of course, "multiplying words without knowledge." Notes may be made so verbose as to be bunglesome, bootless labor, just as is the painstaking gathering of witless data.

A form of record adaptable to all engineering work and to all engineers from the student to the specialist is the working diary. Such a record almost never comes amiss; its value is so well known that comments are almost superfluous. The persistent regularity with which a diary must be kept going is extremely trying, yet in personal satisfaction over the absolute knowledge it gives of past events, which a diary contributes in such degree, it repays all the labor expended. In case of dispute such a record is almost invaluable, and in legal affairs it is accorded marked consideration, even if merely used to refresh memories ever growing stale. No more praiseworthy habit can be formed than the keeping of a continuous diary of facts. No one's life is so bare but there are matters worthy of record—facts which may become of use. A personal experience on the witness stand where a small diary served as an appreciated staff, is fresh in the mind of the writer, and served to impress upon him the great use of such records.

Letter writing and correspondence form one of the most universal and important forms of record. Letters betray characteristics to the distant recipient, neatness or slovenliness of body or of mind, and impress him for or against us inevitably. Moreover the most important thing in any business transaction is for the letter to convey to the recipient the meaning intended by the writer. Use the words that will convey to some one else the impression you want to make. The composition of a letter must conform to this rule to be effective. When you get through saying something stop.

When you send away a record of your-

self into the hands of another person at a distance you ought to have a copy of that record for your own satisfaction and safety. A most primary business caution that can always be practiced with benefit is the preservation of a copy of all letters of a business nature. The copy press is usually available, or the convenient roll book may be used.

The proper filing and keeping track of letters has among modern business men reached a high degree of efficiency. A method once much in vogue was to file all letters received alphabetically and consecutively, and an answer to all letters would be found in the press copy book of the same date. This scheme has some advantages, but is now largely supplanted by filing under subject and individual, briefly outlined as follows:

To each letter a carbon copy of the reply is attached; and it is possible immediately to trace through the whole correspondence on a given subject. Each letter written deals about one matter preferably, or about allied points of one matter; and where several widely different subjects are to be attended to, a separate letter is to be written on each. Take for illustration a manufacturing concern. Each piece of work will be given a contract number and a folder provided for each correspondent who writes about that contract; one general folder or drawer or box is provided to include all the individual folders, and the whole correspondence about the contract is at once at hand. Often you see on business letters this legend, "Please refer to file No. —." And often also a line stating the subject. In addition to the carbon copy of the letter a press book copy is kept. You will find substantially this system in use in most of the railroad offices, as well as in private business concerns. Any system of filing or recording correspondence has the same end in view of a systematic arrangement of the records to secure their permanence and availability. A discussion of filing is equally applicable to all other kinds of records, as well as to letters. Numerous systems have been developed and are in use for keeping records of various kinds. The best system for a given case is dependent on the particular phase of information wanted from that record, and the frequency of that want. These two factors must be approximately determined, and a filing system developed accordingly. For instance, Tuttle & Pike in Kansas City do a very large city survey business, and they have developed a system of indexing the notes of their innumerable surveys for past years, so that in an astonishingly short time they can give you the references to a lot corner or a street corner. It is the daily, maybe hourly, occurrence to seek such references. In other offices of slightly different scope of work this careful indexing of street references is not necessary or desirable, for that particular form of information is required only at intervals.

and it is economical to spend more time looking for a reference than so much time in the preparation of an index to be but seldom used. It is well to remember that indices and files are useful only as they lighten the total labor and expenditure of time. There is no sense in spending more time in sharpening the ax than in cutting down the tree.

This is the age of the card index. It confronts us on every hand; it shouts with capital letters on the street car advertisement and every one knows that no matter what he has to file, no matter what kind of data he is troubled with, no matter how limited or extensive his filing needs may be, everything is provided for. A more satisfactory system has not been invented; but in becoming enthusiastic over any cataloguing scheme it must be always remembered that the index is the servant, not the master; the means, not the end.

Drawing as a means of recording and conveying thought is one of the most interesting to me of the methods of making records. To originate a detail or combination of details, and then to put down on the drawing board your plan and your detail so as to carry out your scheme is a most engrossing occupation. In plans, the same as in other records, the identical, axiomatic, obvious, simple rule holds sway. The record, if not intended merely for personal use, must convey to some one else a meaning. The humiliation of an inexperienced draftsman whose plan, on being manufactured by some mechanic, turns out different from what he intended, and with good reason, from the workman's standpoint, is not the only unfortunate result of a drawing which does not embody data so arranged as to be understandable by the user as well as the maker.

One matter which should receive care in plan making is the mutual correlation of various parts. Usually in an extensive work contractors or mechanics have plans only of their particular share, and build in accordance therewith, trusting entirely to the detailer that their portion will fit to the work of the other builders. Especially when a change is made on one drawing or on one detail it should be traced throughout all the parts that may be affected. For instance, I have set anchor bolts according to substructure plans, only to find later that the steel work would not fit, a mistake due wholly to limited corrections.

If a drawing is made for construction, it is well to remember that, however easy it may be in the drawing room to spread three or four sheets out on a desk and compare from one to another to find one lone-some dimension, it is an entirely different thing when you are shoe deep in mud, with the rain dripping on your print.

A plan should either frankly acknowledge that the details are to be left to the user or else should give every detail exactly. If the former, well and good; the user can proceed on a basis of adapting his own

ideas and the maker of the plans will become a smaller and smaller factor in the matter. Unless it shows him what it pretends to, a plan is a trouble instead of a help; unless a map really indicates the geographical relations it is supposed to, it is of little use. There is some discussion from time to time regarding shop drawings for structural steel, as to when the advantage and economy of making them ceases and it becomes advisable to lay out in the shop directly without templates. The same general proposition is met with in any kind of drawing. To work to that point only in accuracy of detail which will be of advantage to the ultimate end should be the aim of the plan maker.

In the main the deficiencies of drawings as records, aside from the matter of ordinary mistakes and ordinary errors, are due to a lack of conception on the part of the plan maker as to how the user of the plans will perform the work. The natural conclusion is that only the man who has done the class of work involved can properly make the plan. This is not always practicable, but it is always possible for the designer and detailer to have clearly in his mind just how he would take each step, if he were to follow the plan and build thereto. Sometimes you will come across the plan of a structure, a careful examination of which will show that it has been made so that it will be utterly impossible to construct the work by any known method. In fact it would be necessary for the whole edifice to spring into existence at once. It is not uncommon to find in steel work instances where members must first be taken apart before they can be put together, and rivets which no human riveting tool can drive. I have seen plans, supposedly complete, for substructure for bridges and arches, from which it was not possible without considerable additional figuring to proceed to the laying out of the work, even though the sheet was abundantly supplied with dimension lines and certain dimensions. If the maker of a plan could not lay out his work from his own drawings, he accords a superior wisdom to some one else to make anything out of them.

A carefully made plan is certain to save expense in time and labor by having the thinking out done only once. The leading features and dimensions should be given the most prominence, and the lesser followed out in regular order, till those details are reached which will be worked out in less time by the user than by the maker. Above all, in making plans intended to convey information, there must be information to start with.

An important form of record for promoting the advancement of engineering knowledge is the record of completed work. Sometimes the anxiety to stop expense immediately on the cessation of work causes records to be left in an unfinished condition, and at later times this turns out

to be an expensive economy. Theoretically when a piece of work is finished, the records of that work are finished also, but practically this does not always follow, and a short time spent in indexing and arranging working notes when they are fresh will save much time later. For instance, it may at some time be of importance to know quickly just how deep the piles of a certain trestle were driven, or what load a certain floor was figured for, or what pressure per square foot was allowed on certain material, or even who inspected certain work. The idea sometimes expressed that now we have our building, or bridge, or embankment, or cut, we can look at them and tell how big they are is so unwise that its prevalence is surprising. When a work is completed, the best thing is either to make a new drawing showing the structure as built, or, better perhaps and cheaper, is to take the tracing of the original plan and mark "As built" on each governing dimension, and give data of revision, in no case erasing the original plan. For it sometimes happens that after a lapse of time plans are looked up for some data as to the existing structure, and it is easy to confuse the actual with the original plan, it being rare indeed that a plan is carried out in detail as at first contemplated. Aside from the personal value of a record of completed work, there is a value to the profession at large. It is essential that records be made of complete work, so that it may be studied later as a basis for the general engineering information which we all depend on for the advancement of the profession.

The criticism may be made that the keeping of such exhaustive records is so expensive and demands so much time and attention that after all it is not worth the pains necessary to keep it. Records of course are utilitarian. Every engineer must determine for himself how far he will go and how completely he will keep his records. The purpose of this article is to emphasize the prime importance of record making in general and the characteristics it must possess to be valuable as record matter. The various branches of the science of record taking and keeping can be determined by each engineer as he goes along, and he must decide where to draw the line between expense and completeness of record. But he should realize that the record is in general one of the most important features of an engineering undertaking, and that the ability of making appropriate records for a given piece of work is something he should devote himself to acquiring.

To summarize the principles the writer considers important to keep in mind in the making of engineering records, the following points may be mentioned:

Records are for information, therefore they should be legible, concise and comprehensive, permanent, accurate and intelligible.

It may be borne in mind that memory is fallible; paper is cheap; that books were invented to keep together loose sheets; that if a record is correct one time, it usually never needs to be made over again; the only safe rule is to make the record entirely complete when preparing it. To be usable, records should be so filed and stored as to be available, for the beginning where we start and the ending where we finish have the one criterion, *records are for information, and the test for a record is will this inform?*

Record making is but one of the details of our profession, but perfecting that detail will be of advantage on the whole in order that past achievements may be surpassed, that the deserved confidence and status be accorded our profession in the minds of the general public and that more economically and more efficiently the great forces of nature may be utilized for the advantage of mankind.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0862. **Concrete Machinery.**—Miracle Pressed Stone Co., Minneapolis, Minn.

This large 143-page book lists the complete and varied line of machines, tools, supplies, etc., made by the above well-known concern for concrete workers. Block machines and molds of all kinds are the important specialties of the firm. The molds for cement sewer pipe are very complete and their merits are fully presented in the book. Other notable devices are collapsible molds for culverts, Mastodon and X-L-All traction concrete mixers, and molds for ornamental work. The book in addition to describing the various machines and tools listed gives a large amount of useful information for doing concrete work of all kinds. Concrete workers should secure a copy.

No. 0463. **Steel Mine Timbers.**—Carnegie Steel Co., Pittsburg, Pa.

This 35-page pamphlet presents an exceedingly well thought out argument in favor of the economy of steel timbers for mining work. A brief history of the methods of timbering mines is given and is followed by a statement of the advantages of steel timbers, the method of using them and their economy. Line drawings and half-tones show the construction and installation of steel timbers. The pamphlet is of interest not only to the mining engineer, but to other engineers for the technical information it gives on the subject of mine timbering.

No. 0861. **Concrete Facts.**—William B. Hough Co., Chicago, Ill.

This 18-page pamphlet gives a variety of well selected information on the materials, proportioning, mixing, transporting and placing of concrete. Methods of joining new concrete to old, the fire resisting qualities of concrete, concrete as a protection of metal, etc., are also discussed. The pamphlet is worth securing.

No. 0865. **Contractors' Tents.**—Morrison Tent & Awning Co., St. Louis, Mo.

Complete lists of stable and contractors' tents, camp furniture, oil and canvas clothing, tarpaulins, etc., are given in this 24-page catalog.

No. 0866. **Conveying Machinery.**—Howe Seale Co., Chicago, Ill.

This pamphlet illustrates and describes some of the various conveying machines made by the company named, which makes a specialty of machinery for handling freight,

packages, barrels, boxes, sacks, bales, merchandise of all kinds, or any material that requires to be transferred in warehouses, freighthouses, powerhouses, boilerhouses, mills, and to or from storage on marine docks, railroads, etc., horizontally, vertically, or on an incline.

No. 0867. **Hoisting Machinery.**—The National Equipment Co., Chicago, Ill.

A wide variety of machinery is included in this 40-page catalog. There are steam, electric and gasoline hoisting engines, derricks and derrick fittings, drop-bottom and clamshell buckets, pneumatic motor and cylinder hoists and lifting magnets. Other specialties include dump cars and wagons, concrete mixers, pumps and a portable stone crushing machine with conveyor attachment.

No. 0868. **Portable Steam Hoisting Engines.**—John F. Byers Machine Co., Ravenna, O.

This 75-page catalog lists portable and semi-portable steam hoisting engines, geared locomotives, derrick cars, and blocks and sheaves for contractors and quarymen. The engines are of vertical, self-contained type, with plain flue boilers, made of open-hearth steel.

No. 0869. **Ferro-Lithic Plates.**—Berger Manufacturing Co., Canton, O.

The "Ferro-Lithic" roof slab consists of corrugated, cross-ribbed, 24-gage steel plates, concreted on top and plastered underneath. In curved form these plates are adapted to floors sustaining heavy load, as in schools, factories, warehouses, bridges, etc.

No. 0870. **Subaqueous Rock Cutters.**—Carr Bros., New York City, American agents.

This rock cutter consists of a heavy chisel of steel weighing from 10 to 15 tons and fitted with a hard cutting point. This is allowed to fall from 6 to 10 ft. upon the rock. One ton of coal and the labor of four men is required, with an average result of 100 cu. ft. of rock broken per day.

No. 0871. **Blasting Machines.**—The Aetna Powder Co., Chicago, Ill.

This pamphlet describes each of the company's four sizes of blasting machines, and gives directions for firing, for care of machine, etc.

Personals.

T. Edward Lomb, of the firm of Laurie & Lamb, Consulting and Contracting Engineers, Montreal, Que., died Aug. 13, at Caledonia Springs, aged 44 years.

Charles E. Higbee, a well-known tunnel contractor, was killed Aug. 11, by a broken guy wire at Shoshone, Colo., where a camp of the Central Colorado Power Co., is located.

Mr. Hugh L. Cooper, M. Am. Soc. C. E., and Mr. W. V. N. Powelson, Assoc. Am. Inst. E. E., have formed the corporation of Cooper & Powelson, and will engage in practice as consulting hydraulic and electrical engineers, with offices at 60 Wall St., New York City.

Mr. Nelson O. Tiffany, Jr., Assoc. Mem. Am. Soc. C. E., and Mr. Harry M. Gall, Mechanical Engineer, have formed a partnership and will continue the practice of their profession as engineers and contractors under the firm name of Tiffany & Gall, with offices at 1010 Mutual Life Building, Buffalo, N. Y.

The Canadian Government has appointed Messrs. H. E. Vautelet, C. E., Montreal, Que., Maurice Fitzmaurice, London, England, and Ralph Modjeska, Chicago, Ill., as a board of engineers to design and construct the Quebec bridge. Mr. Vautelet, who will be chairman, is one of the leading civil engineers of Canada, having been connected with the bridge construction work of the Canadian Pacific Ry. for many years. Mr. Fitzmaurice is at present chief engineer for the London County Council. He was associated with Sir Benjamin Baker in the erection of the Forth Bridge, and was also one of the engineers on the construction of the Assouan dam. Mr. Modjeska has had much experience in the building of railway bridges in the western United States.

Mr. E. J. McCaustland, M. Am. Soc. C. E., has been appointed Professor of Municipal Engineering at the University of Washington, Seattle. Professor McCaustland's successful career in teaching as instructor and Assistant Professor at Cornell University and as Professor at the Missouri School of Mines and the University of Alabama, together with an extended practical experience including City Engineer and other municipal work at Salem, Ore., in the "nineties" and Principal Assistant Engineer in charge of a portion of the water supply, sewer and track work in connection with recent track elevation in Chicago, gives assurances that not only will the instruction in Municipal Engineering at the University of Washington be well provided for, but that the institution will gain a splendid all around technical man.

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METHODS AND COSTS 157**LETTERS TO THE EDITORS** 158**Announcement in October of the Organization of the American Society of Engineering Contractors.**

In our issue of Oct. 7 we shall print the names of the 1,000 and more contractors and engineers who have applied for membership in the American Society of Engineering Contractors; and, immediately following that, the Society will be formally organized. In the whole history of technical or engineering societies there is no record of any such enormous charter membership as the American Society of Engineering Contractors will possess. All other societies have started with a few score of members at most, and have been many years in growing to a membership as large as this Society will start with.

A thousand men is a large number, as membership in societies goes, but it is small indeed compared to the number of readers of this journal. Yet we feel that there are very few of our readers who would not be well repaid by joining. The new Society will be a common meeting ground for the men who design and the men who build civil engineering structures.

The Society may easily aspire to having a membership of 10,000 within the next few years. Its dues will be comparatively nominal, yet the benefits derived will be great.

We have, from time to time, outlined some of the objects of this Society, and shall do so again; but, for the present, we refer our readers to advertising page 6, where the objects of the Society are briefly enumerated, and where a blank to be used in applying for membership will be found.

The Disuse of C. E. by Civil Engineers.

One who has occasion to refer to the technical periodicals and transactions of twenty years ago will find innumerable mentions of civil engineers by name, and almost always with the letters C. E. after the name. It was a matter of pride as well as a means of professional identification that led to the practice of using the suffix C. E. Latterly this practice has almost died out—and why?

Unquestionably the practice came into disrepute because of its abuse. Men who had little more knowledge of civil engineering than is needed to run a compass imitated the real civil engineer, by adapting their title and using its abbreviation after their own names. There was no law to prevent such misrepresentation, and the natural outcome was that many civil engineers abandoned the use of C. E. in disgust. We cannot help feeling that it was a mistake to do so. What engineers should have done was to appeal to state legislatures for protection, just as lawyers and doctors had appealed years before.

It is undoubtedly true that a man who would be legally entitled to use C. E. after his name, might, in fact, be a very poor civil engineer. The same holds true of

many an M. D., but the general standing of the profession is raised in the eyes of the community by the use of legalized titles or degrees. The question is not, as many have supposed, what one engineer thinks of another. It is what the community thinks of engineers as a class. The opinion of a community is undoubtedly influenced in favor of any profession that has a legal protection in the use of the title that designates its members.

In recent years many civil engineers have come to regard membership in the American Society of Civil Engineers as being a better badge of engineering ability than could be secured in any other way. We cannot agree with those who hold such beliefs.

There is many a young engineer upon whom the burden of paying dues in the Society of Civil Engineers is sufficient to prevent his applying for membership. Shall such civil engineers be denied the right of being recognized as members of good standing in the great profession?

The growing number of state societies of civil engineers proves the need of some recognized standard of qualifications as a civil engineer. It is true that these state organizations provide the social and mental stimulus that most men relish, and they are therefore destined to survive; but we cannot avoid the conclusion that they are also very attractive to the young engineer because membership in them gives a man a standing as an engineer that he would not otherwise possess.

Most of our readers know that the Canadian Society of Civil Engineers secured the passage of a law, some years ago, that compels every man who practices engineering in Canada to become a member of that society.

Why cannot the same sort of a law be secured in each state of the Union?

Why cannot each state society of engineers become the examiners of those who must apply for membership before they can practice engineering in that state?

Why cannot the membership in the civil engineering society of one state be a sufficient license to practice engineering in other states?

Why cannot all engineers who are members of these state societies adopt the good old practice of proudly placing C. E. after their names?

How many civil engineers there are in America no one knows exactly, but probably not one-fifth of the number now belongs to the American Society of Civil Engineers, large and powerful as that organization already is. Nothing can or should stop the growth of our national society. Indeed, the formation and growth of state societies will react helpfully upon the national society; but what is needed now is local spirit and enthusiasm enough to build up strong state societies, which will eventually redeem the combination of the third and fifth letters of the alphabet from the disrepute into which they seem to have fallen.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Sands: Their Relation To Mortar and Concrete.*

BY HENRY S. SPACKMAN† AND ROBERT W. LESLEY.‡

Table I, which follows, shows the tensile tests of various commercial sands tested in comparison with standard Ottawa sand, the methods prescribed for testing cement in the standard specifications being followed. The results given in each case show the average of five briquettes; where several sands are bracketed together the results are directly comparative, the same cement being used:

Table I.—Comparative Tests of Commercial Sand and Standard Ottawa Sand.

	Tensile Tests Commercial Sand.		Tensile Tests. Standard Sand.	
	1 cement, 3 sand. 7 days.	28 days.	1 cement, 3 sand. 7 days.	28 days.
A.	135	207	319	489
B.	369	395	319	489
C.	211	313	339	518
D.	327	445	339	518
E.	163	329	339	518
F.	230	306	338	514
G.	207	282	362	441
H.	104	143	310	441
I.	166	243	310	441
J.	154	329	310	441
K.	402	499	220	400
L.	21	130	266	407
M.	271	363	327	447
N.	85	232	160	268
O.	191	301	329	447
P.	182	284	329	447
Q.	295	478	266	407
R.	135	209	327	447
S.	129	205	253	363

Sands A, E, and I, are commercially known as Philadelphia Bar Sand.

C.—Jersey Gravel.

H.—Susquehanna Bar Sand from Harrisburg.

J.—An artificial sand made by crushing a very fine grained sandstone.

F.—From New England.

D.—Bar Sand.

K.—Gravel from small river flowing through shale formation.

L.—Sand formed from decomposition of granite rock.

M.—Cowley Sand from Long Island.

N.—Sand from California of granitic origin.

O.—Sand from Hornos, Mexico.

P.—Sand from Gomez Palacio, Mexico.

Q.—A synthetic sand made from pure quartz.

R.—Sand from California of granitic origin.

S.—Unknown.

The sources of B, and G, are unknown. Sands K, L, N, and R all proved satisfactory in actual work.

Table II is calculated from the tests shown in Table I. To eliminate variations due to the cements the same letters refer to the same sands.

The first column of figures gives the per cent of strength of standard sand, the commercial sand developed.

The second column shows the calculated breaking strength at seven days, obtained by multiplying the average strength per square inch of briquettes, made from Ottawa sand and various commercial cements

in the proportions of one cement and three sand. This average strength is 253 lbs. per sq. in. and was arrived at by averaging the seven-day tests, one cement and three sand, in the laboratory of one of the writers for the past year.

The third column shows the per cent of strength of standard sand developed by the commercial sand at 28 days.

The fourth column shows the calculated breaking strain at 28 days, obtained in the same manner as in the seven-day test. The factor used for the strength of standard Ottawa sand briquettes for this period being 368 lbs. per sq. in.

TABLE II.

	Per cent of strength of standard sand developed.	Calculated value, lbs.	Per cent of strength of standard sand developed.	Calculated value lbs.
A.	42	106	42	154
B.	115	291	80	294
C.	62	156	60	220
D.	96	242	86	316
E.	48	121	63	231
F.	68	172	60	220
G.	57	141	64	235
H.	34	85	32	118
I.	53	134	55	202
J.	50	126	74	272
K.	182	460	124	456
L.	08	20	31	113
M.	80	202	80	294
N.	53	134	80	294
O.	58	146	74	272
P.	55	139	64	235
Q.	110	278	110	404
R.	40	101	40	147
S.	50	126	56	206

Table III shows the granulometric composition of various commercial sands tests, and physical, one cement and three sand, and comparative tests with standard Ottawa sand.

The letters and numbers used to identify the different sands for the first thirteen tests are the same as used previously in this paper. These tests were made by the writers and the remaining tests marked "S. D. 1 to S. D. 22" were compiled from "Portland Cement Mortars and Their Constituent Materials," by Richard L. Humphrey and Wm. Gordon, Jr. No direct comparative test is given between these sands and Ottawa sand and the figures

used to denote the strength of standard Ottawa sand mortar was the average given for tests of the mixed cement with standard sand, Table No. 2-B, page 18.

In comparing these latter tests with these given in other tables it must be remembered that they were made from cement and sand especially selected for laboratory tests, while the others were made from sand and cement taken from the work and in Table No. 3 sands No. 1, A., B., C., N., and R. failed in work.

The various tests given in this paper are not presented as an exhaustive research into the action of sand and cement mortars but, on the contrary, are cited with full recognition of their fragmentary character; but we think they prove conclusively that the strength of cement mortars and concrete is dependent as much on the sand as on the cement and show the necessity of careful and systematic inspection and testing of the sand and also the desirability of the development of standard methods of testing and their general adoption so that the work of different engineers may be comparative.

Fully realizing the inefficiency of the data before us and of the necessity of further research and experimental work before a general specification can be drawn that will meet all conditions, it is with some hesitancy that we give the specifications and methods of tests adopted by one of the writers in his work. These specifications and methods of testing being offered as our contribution to what we hope may prove to be a general discussion and investigation of the subject, rather than as a definite statement of what is required to secure the best sand for cement mortars and concrete.

SPECIFICATIONS.

All sand used in the work shall be subject to the following tests:

The contractor shall furnish the sand in such manner as to allow of its being tested before being used in the work.

Size.—The sand shall be of such fineness as to all pass a No. 4 screen.

Chemical Composition.—The sand shall contain at least 95 per cent of silica.

Before acceptance of the sand the contractor shall furnish to the engineers average samples taken from the source of supply, which shall be subject to analyses, and comparative physical tests with standard Ottawa sand.

The sand shall develop, when tested, in the proportion of 1 cement to 3 with sand a normal Portland cement according to standard methods, at least 50 per cent of the strength developed by the Ottawa sand at the 7 and 28 day periods. In no case shall a 1 to 3 mixture briquette fail at less than 100 lbs. at 7 days or 150 lbs. at 28 days. The sand when tested with 50 per cent excess water over that called for by the standard methods shall develop at least 75 per cent of the

* Abstract of a paper read before the American Society for Testing Materials.

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‡ Associate Am. Soc. C. E.

strength developed when tested according to standard methods.

After full tests have been made to determine the character of the sand, each car-load shall be subject to tensile tests and must develop at 7 days at least 80 per cent of the strength shown in the preliminary tests on which it was accepted.

Determination of mineralogical compo-

this character cannot be obtained, modifications would have to be made in the specifications.

The mechanical analysis of the sand as called for in the specifications is exceedingly simple, requiring only a No. 4 screen. The writers fully realized the value of the work done by other investigators covering the granulometric composition of sands

order to compare the action of the sand and cement under the best conditions with the results obtained with a known sand such as standard Ottawa sand. The writers' experience, however, leads them to believe that these tests cannot be depended upon as indicating the actual action of the sand in the work.

A number of similar experiences led the

TABLE III

Mark	Kind.	Per Cent by Weight Passing Previous Sieve and Retained on Sieve Number.										Passing 200 Sieve	Tensile Strength. Lbs. per Square Inch.					Tensile Strength Lbs. per Square Inch. Standard Ottawa Sand.						
		4	10	20	30	40	50	60	80	100	200		7 Days	28 Days	90 Days	180 Days	270 Days	One Year	7 Days	28 Days	90 Days	180 Days	270 Days	One Year
3	Bank	0.0	1.4	13.9	15.1	11.9	13.3		18.2	8.4	11.6	6.2	180						241					
4	"	1.0	1.3	24.6	45.3	14.3	7.8		3.6		4.6	1	108						241					
5	"	3.0	6.5	16.4	21.3	19.5	16.2		15.2	1.7	1.3	1	170						241					
A	"	0.0	35.9	20.0	14.3	9.7	9.3	3.8	3.2	1.2	2.5	21	130						266	407				
B	"	0.0	36.1	20.1	15.9	11.2	7.2	3.6	3.2	1.2	1.5	78							266	407				
C	"	0.0	32.1	18.4	13.9	10.8	9.4	4.8	5.5	2.0	2.9	22							266	407				
O	"	0.0	39.0	18.7	11.0	9.7	9.3	5.0	3.1	1.5	2.7	295	478						266	407				
H	Bar	0.0	1.1	4.4	11.5	9.9	24.3	21.3	21.5	4.5	1.5	104	143	246	243				310	441	246	482		
I	"	0.0	0.92	2.91	9.05	25.21	36.28	14.54	7.18	1.4	2.51	166	243	320	243				310	441	320	482		
M	Crushed Stone	6.0	4.8	6.3	6.6	7.20	10.7	9.9	17.2	15.6	20.7	154	329	393	424				310	441	393	482		
N	Bank	0.0	16.71	15.65	15.35	20.85	6.82	10.35	4.05	4.01	6.75	271	363						327	447				
R	"	12.89	23.87	26.13	14.45	7.82	6.53	3.29	3.87	0.0	3.15	85	237	424					160	268				
Sand 1	Bar	0.0	0.2	3.55	21.0	23.90	24.90		21.7	3.5	1.25	129	205						253	363				
2	"	0.0	3.2	10.3	29.3	29.8	5.7		2.2	3.4	14.8	9	390	480	473	415		368	213	453	510	433		457
3	"	0.0	5.4	25.4	26.0	25.7	12.8		4.2	4	1	343	435	491	369			320	213	453	510	433		457
4	Bank	0.0	24.7	23.2	15.0	13.2	9.4		6.6	1.9	1.9	3	392	522	515	495		565	213	453	510	433		457
5	Bar	0.0	33.0	34.9	15.2	8.4	4.4		2.1	4	3	9	521	618	755	731		773	213	453	510	433		457
6	Bank	0.0	18.5	22.7	19.7	23.4	11.4		3.3	3	1	410	499	555	420			415	213	453	510	433		457
7	"	0.0	15.5	15.9	16.0	20.5	17.7		9.1	1.7	1.9	12	490	622	705	614		754	213	453	510	433		457
8	"	0.0	7.4	14.4	17.0	23.3	21.4		12.0	1.9	1.1	7	417	527	519	603		635	213	453	510	433		457
9	"	0.0	30.7	22.2	14.2	13.7	10.7		6.0	9	6	6	545	628	745	720		689	213	453	510	433		457
10	"	0.0	31.1	17.3	12.2	15.0	14.4		6.5	1.0	8	13	401	493	495	483		525	213	453	510	433		457
11	"	0.0	6.4	12.0	14.3	18.6	21.5		18.0	4.6	3.0	12	411	547	659	488		596	213	453	510	433		457
12	Mix of Sand & Limes' in Segs	10.0	32.4	20.9	9.7	8.1	8.8		10.9	3.3	2.3	3	428	602	651	708		735	213	453	510	433		457
13	Bank	0.0	33.3	34.7	11.8	7.5	7.2		7.3	2.4	2.2	2	407	597	622	601		806	213	453	510	433		457
14	Bar	0.0	30.9	30.4	14.4	10.0	6.7		5.2	1.0	4	2	543	585	655	668		788	213	453	510	433		457
15	"	0.0	7.4	21.4	12.0	13.3	15.3		15.2	6.7	5.7	2	422	444	433	484		579	213	453	510	433		457
16	"	0.0	1.0	1.8	2.0	8.5	25.3		44.7	9.6	4.5	1	312	335	374	331		377	213	453	510	433		457
17	Bank	0.0	39.5	27.5	11.6	9.4	6.8		3.0	8	4	3	471	518	581	605		650	213	453	510	433		457
18	"	0.0	8.4	7.5	7.8	14.3	24.2		25.4	6.1	3.6	1	343	361	436	466		476	213	453	510	433		457
19	"	0.0	4.1	16.3	16.0	19.0	13.8		16.3	4.1	5.0	4	366	477	514	550		555	213	453	510	433		457
20	"	0.0	27.1	26.9	16.4	14.3	7.2		5.2	1.8	6	7	535	654	675	773		807	213	453	510	433		457
21	Bar	0.0	23.3	26.5	13.9	11.7	7.7		11.7	1.9	1.3	1	440	556	598	670		703	213	453	510	433		457
22	"	0.0	1.0	7.3	7.6	20.0	43.5		18.0	1.6	2	1	287	356	341	380		390	213	453	510	433		457
	"	0.0	7.33	23.7	14.3	21.6	15.8		15.1	1.7	5	1	277	442	449	487			213	453	510	433		457

* Sand failed in work.

sition of sand more particularly the percentage of mica and clay matter in the sand, is a difficult analysis and one for which, to the writer's knowledge, no proper method has been evolved. The clay matter in the sand can be determined by boiling in concentrated sulphuric acid in which the quartz, feldspar and mica are practically insoluble. The determination of the percentage of feldspar and mica remaining in the quartz is not difficult, but the separation of the feldspar from the mica is exceedingly difficult, and any methods known are only approximate and attended with considerable possibilities of error.

Sedimentation has been suggested as a method of separating the mica from the feldspar in quartz, but the writers do not know of sufficient tests having been made to determine the accuracy of this method and therefore confine the chemical work to determinations of silica. If, however, a full mineralogical analysis is desired covering clay matter, feldspar and mica, the methods suggested by Seger for clay and Vogt for mica can be used, but the results will only be approximate.

For this reason we confine the chemical work to determination of silica alone and specify a high content. Where sand of

and while those will materially effect the strength of mortars as determined by the ordinary tensile tests, do not think they are of sufficient importance in their effect on the ultimate strength of concrete masses provided the sand gives good physical tests to require special specifications and warrant the increased cost that might be involved in securing a sand of specified granular composition. If it is desired, however, to cover the granulometric com-

author of the specifications to adopt in his laboratory the following method of testing sand:

Sand to be tested is made into a 1 to 3 mortar by weight with a normal cement according to the standard specifications for tests at 7 and 28 day periods, a similar set of briquettes being made in the same manner from standard Ottawa sand. A second set of briquettes is then made from the commercial sand, using 50 per cent more

TABLE IV.

Mark.	Tensile Test Standard Specifications.					50 Per Cent.	Tensile Test Excess Water.					Ottawa Sand Standard Specifications.				
	Per Cent.	7 28 90			Per Cent.		Days	28 90			Per Cent.	7 28 90				
		Days	Days	Days				Days	Days	Days		Days				
Case A	9.8	402	499	...	15.	108	238	...	9.8	220	400	...				
Case B	10.	369	395	...	15.	79	123	...	9.	319	489	...				
Case C	12.	135	207	...	18.	118	154	...	9.	319	489	...				
Case D	8.08	319	489	...	13.2	102	231	...	9	160	268	...				
Case E	11.	85	237	...	16.5	63	157	...	9.	327	447	...				
Case F	10.	271	362	...	15.	152	290	...	9.8	327	447	...				
Case G	11.	246	306	...	16.5	203	301	...	9.8	327	447	...				

* "A", "B" and "E" failed in work.

position in specifications, this can be best determined by practically standard methods suggested in the books of Hazen, Ferret, Taylor and Thompson and other authors.

Tensile tests of actual mortars should be made in accordance with the standard specifications for the testing of cement in

water than required for normal consistency, the mortar being thoroughly worked for 10 minutes prior to being placed in the molds. The effect of so treating sand is indicated by Table IV.

Lately some experimental tests have been made where the sand and cement to be

tested are placed in a revolving vessel with flint pebbles, the object being to approach as nearly as possible the conditions obtained in a concrete mixer. These tests, however, have not been carried sufficiently far to admit of judging of the value. Table V gives an idea of the results obtained by this last method of testing.

The purpose of this test is to ascertain the effect on the sand of the excess water and grinding action of the concrete mixer. The test was suggested by the fact that sands which gave good strength in laboratory tests failed to make as good concrete as was made from other sands testing lower. This was attributed to the breaking down through the grinding action of the mixer of the softer particles in the sand, increasing the quantity of fine material present and distributing any deleterious substances through the mass.

While it is probable that on long-time tests the wet mixes would approach more nearly the dry mix in tensile strength, the early strength developed is an important element to be considered in selecting sand for reinforced concrete construction.

The whole subject of testing of sands is open to investigation and will require careful experimenting and a number of tests before definite methods can be established.

The chemical action and mineralogical composition of sand should also be carefully studied. That this influences the hardening of mortars is unquestioned, but there is no general agreement among writers on this subject. Mica is generally considered detrimental. Mr. W. N. Willis found that the addition of 2½ per cent of finely ground mica to Ottawa sand reduced the strength of the mortar at 28 days about 33

is no known chemical reaction between the mica or clay and portland cement during hydration.

If the effect is other than physical it must be brought about by some obscure catalytic or electrolytic action which may either alter the speed of crystallization or the size and arrangement of the crystals or effect in some unknown way the colloidal action.

Clay matter in order to be injurious must apparently be hydrous, as dehydrated clay in the shape of crushed bricks, etc., has been used successfully for concrete aggregate.

The action of feldspar is not so well defined and it is probably not injurious unless partially decomposed. Crusher dust obtained from crushing hard feldspathic rocks, such as granite, has been successfully used as a substitute for quartz sand, yet as clay is formed largely from the weathering of feldspar its presence in natural sand to any large extent should always be regarded as a cause of suspicion. Decomposed or partially decomposed organic matter is also objectionable.

The nearer the sand approaches in its mineralogical composition to pure quartz the better will be the results obtained, other things, such as size, granulometric composition, etc., being equal. It would, therefore, seem wise, until such time as full investigation has shown that the presence of other materials has no injurious effect, to confine ourselves to the use of as nearly pure quartz as can be commercially obtained.

The full amount of money which the United States Government will pay to all claimants for lands overflowed or otherwise damaged by the construction of the Isthmian Canal will not reach \$300,000, according to the Canal Record. The damages awarded by the Joint Commission amounted to \$143,980. Those awarded by the umpire, Edwin Denby, amount to \$61,000. In certain claims previously adjusted, damages amounting to about \$50,000 were awarded, making a grand total of \$254,980. This amount may be increased somewhat when final payments are made, but the total will not reach \$300,000. The prices agreed upon by the Joint Commission ranged from \$25 gold, per hectare (about 2½ acres) for improved lands, to 10 cents, gold, per hectare, for swamp lands.

Figures of the lumber cut in 1907 compiled by the Bureau of the Census and the Forest Service showed the largest total ever reported in the United States, exceeding by over seven per cent the cut reported for 1906, until then the record year. In 1907, 28,850 mills made returns, and their production was over 40 billion feet of lumber. This is believed to include 95 per cent of the actual cut. In 1906, 22,398 mills reported about 37½ billion feet.

Reinforced Concrete Boats.

As writers on metallurgy always refer to Tubal Cain so writers on reinforced concrete refer always to the boat built by Lambot of this material in 1850. Monier, the nominal inventor of reinforced concrete, came into prominence with his garden pots fully five years later, we are told. Monier soon had imitators, but Lambot's idea of reinforced concrete boat building seems not to have gained believers until nearly 60 years had passed. It is now being worked, however, with notable energy and fleets of reinforced concrete boats are promised by several inventors in Europe and by at least one concrete engineering firm in America. As a matter of news at least the progress being made is worth noting.

In 1907 the Signori Gabellini of Rome constructed a reinforced concrete barge of 150 tons burden for use on the Tiber and in coastwise trade. This boat has been used continuously since being built and, it is stated, has given excellent satisfaction. Subsequently a large number of boats and barges of various kinds have been built in Italy and the Italian government has made many experiments and tests with satisfactory and practical results. The French government is also investigating the use of concrete for use in its navy.

So much for concrete boat building in Europe. In America the Morchel & Lowther Engineering Co. of Kansas City, Mo., has been making experiments on concrete boats for Missouri and Mississippi navigation. So far all the work done has been with models, but we are informed that the "experimental data gained from these models taken with the calculations of the designs of full sized boats of 300 tons and over, show that the difference in weight between steel and concrete, as applied to boat construction, is comparatively small. Concrete offers less resistance to propulsion in water than wood or steel, and no painting is required. The cost of concrete boats is about one-half less than steel boats and the maintenance cost is nothing. One of the best demonstrations of the power of reinforced concrete to resist shocks is the trial made by the Italian government with a steel and a concrete boat. A 1,000-ton concrete boat was rammed by a much larger steel vessel, the result being that the concrete boat suffered less damage than the steel boat. Various trials of this nature have led the Italian government to consider the armoring of their war vessels with concrete."

A report issued in London shows that by order of the British port sanitary authorities, in accordance with a scheme for the extermination of the rat plague, 524,379 rats have been killed up to Aug. 1 in the warehouses and vessels in the docks of London, nearly 6,000 having been killed in one month.

TABLE V.

	Tensile tests, mortar wet and placed in revolving vessel with flint pebbles.					
	Tensile tests, standard method.			Tensile tests, mortar wet and placed in revolving vessel with flint pebbles.		
Mark.	7 days.	28 days.	90 days.	7 days.	28 days.	90 days.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
A-1	150	268	..	90	215	297
B-2	85	237	424	11	132	223

per cent and that the presence of flakes of mica greatly increased the percentage of voids.

Clay matter, by which is to be understood hydrous silicate of alumina and which must not be confounded with fine silicious earth, is often detrimental.

Fine silicious particles unless present in large quantities are not detrimental and may be beneficial with lean mortars and coarse sands, as they tend to make a denser and more impermeable mortar.

The exact action of the mica and clay on the hardening of mortars has not been determined; the probabilities, however, are that the action is entirely physical, as there

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost of Excavating An Irrigation Canal by an Armstrong Excavator.

BY HENRY A. YOUNG,* ASSOC. M. AM. SOC. C. E.

The following cost data were taken on the U. S. Reclamation Project at Huntley, Montana, during the month of September, 1908; the excavator working between stations 134+25 and 149+00 on the main canal.

The Armstrong excavator is of the derrick type, having a bucket swinging from a sheave at the end of the boom. To load, the bucket is pulled toward the engine, thus forcing the cutting edge into the ground. The machine was sold by the H. Channon Co., Chicago, Ill., and had a 48-in. by 8-ft. upright boiler, an 8x12-in. hoisting engine and a 5x8-in. swinging engine.

A 1½-cu. yd. bucket was used during all but the first four days of the month, when a 2½-cu. yd. bucket was used. Throughout the month the machine was used under exceptional and very hard conditions. It had previously been down one bank of the canal and removed approximately the south two-thirds of the cross-section to within 2 to 4 ft. of grade, making about 60 per cent of the total material to be removed. During the month under consideration the balance of the section was excavated with the exception that for 500 ft. the machine lacked 1 ft. of getting to grade.

The cut ran from 16 to 19.5 ft. in depth. Of this the first 12 or 15 ft. consisted of a well compacted sandy soil, the balance of a mediumly coarse gravel and sand saturated with ground water. This class of material and its location was such as to make the efficiency of the machine very low, 16,000 cu. yds. having been moved during the month, this being not far from 70 per cent of the normal output since it had been in operation.

Excepting the ground men, who worked 16 hours, the machine was operated by two crews working 8-hour shifts. The labor and supplies are subdivided into "actual excavation," "lost time (Sundays, etc.)" and "current repairs."

The coal used was hauled an average of 2,000 ft., being shoveled from a pile on the ground to a wagon and from the wagon to bins behind the boiler on the machine.

The water for use in the boiler was pumped as needed by a gasoline engine, the supply being the water in canal from the 1st to 19th and from the Yellowstone river for the balance of the month. The water from the canal gave trouble by priming, which necessitated much waste of time in

blowing out and cleaning the boiler, also some lost time in keeping up steam.

The detailed costs follow:

Excavation Class 1, 16,000 cu. yds.	Days.	Rate.	Total.	Rate per yd. in cts.
Labor—				
Superintendent	10	\$125	\$ 41.67	
2 dipper men	19½	130	171.17	
2 dipper tenders	19½	95	125.08	
2 firemen	19½	85	111.92	
2 ground men	19½	100	131.67	
2-horse team and driver (hauling coal supplies, etc.)	107½	4	43.50	
Laborers	107½	2	21.75	
Total for labor			\$646.76	4.04
Supplies—				
60 tons coal at \$2.25			135.00	
10 gal. kerosene at 22c			2.20	
25 gal. gasoline at 25c			6.25	
10 lbs. cup grease at 9c			.90	
10 lbs. graphite at 25c			2.50	
20 gals. engine oil at 31c			6.20	
25 gals. cylinder oil at 44½c			11.13	
Total for supplies			\$164.18	1.03
Total for actual excavation				5.07
Lost Time (Sundays, etc.)—				
Superintendent	2	\$125	\$ 8.33	
2 dipper men	4	130	34.67	
2 dipper tenders	4	95	25.33	
2 firemen	4	85	22.67	
2 groundmen	4	100	26.67	
Total for lost time			\$117.67	0.74
Current repairs—				
Superintendent	1½	\$125	\$ 6.26	
2 dipper men	3½	130	30.33	
2 dipper tenders	3½	95	22.17	
2 firemen	3½	85	19.83	
2 ground men	3½	100	23.34	
2-horse team and driver (hauling ma- terials, etc.)	5½	4	2.50	
Laborers	5½	2	1.25	
Total for current repairs			\$105.68	0.67
Summary of cost—				
Actual excavation				4.04
Supplies				1.03
Lost time (Sundays, etc.)				0.74
Current repairs				0.67
Total cost in cents per cu. yd.				6.48

The Excavation of Trenches in Quicksand by the Bleeding Method.

In our issue of Aug. 15, 1906, we first described the method of unwatering water-soaked ground by the "bleeding method." In our issue of Aug. 5, 1908, we gave some space to an article descriptive of this method in excavating a sewer trench at Gary, Ind.

One of the editors of this journal has had considerable experience with this method of unwatering earth, and, as its use is certain to become more common, we wish to call attention to some of the details of the work, especially in connection with trenching.

In our issue of Aug. 5, on page 88, a sketch is shown giving the arrangements of well points and pumps. It will be noticed in this sketch that the sheeting of the trench does not extend to the bottom of the ditch. In such material sheeting under ordinary circumstances would not only have to be sunk to the bottom of the

trench but in many cases below it, and such sheeting would have to be almost water-tight in quicksand.

By bleeding the ground, shorter lengths of sheet piles are used. There is no direct pressure on the side of the ditch at the bottom, and the only need for sheeting at the bottom is because the quicksand will flow into the ditch, thus causing the bank above to cave in behind the sheeting. If this ground is unwatered to a small distance below the bottom of the ditch, it becomes evident that the moist sand will stand up below the sheeting within any aid.

One of our editors in digging a trench 12 ft. deep and 3 ft. wide in quicksand did it in the following manner:

The top four feet of material was excavated with drag scrapers, giving the sides a 1 to 1 slope. Water was then encountered and the points were driven and pumping commenced, the rest of the excavation being made by hand. Fig. 1 shows

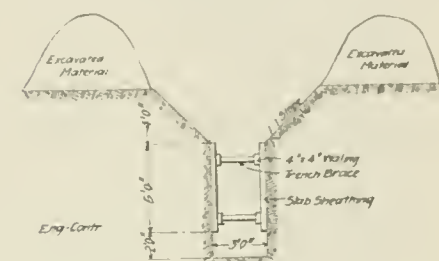


Fig. 1.

the method of doing the work. As soon as the men began to work with shovels the sheeting was driven. For this purpose slab wood, cut in cord wood lengths, was bought for about \$2 per cord from a saw mill. This meant that for a trench 8 ft. deep piles only 4 ft. long were used. This was found to be too short and where the 4-ft. piles were used a cave-in occurred. The slabs were then cut in 6-ft. lengths, and they answered the purpose admirably. A 4x1-in. waling was used. Naturally the slab wood was irregular and left small gaps in the sheeting, but no trouble was experienced from this, and, the 2 ft. at the bottom being free from sheeting, allowed the pipe work to be done much easier.

In back filling the trench dirt was shoveled in over the pipe and up to the lower waling; then the sheeting was taken out and a water jet turned on the banks; this caused them to cave in, bringing down into the trench the excavated material piled on the sides. This was followed by a drag scraper that leveled up the ground. The cost of digging this trench was 12 cents for shoveling per cu. yd., and 4½ cents for shoring, making a total cost of 16½ cents for excavating and shoring, the pumping being extra. This is a low cost for excavating such a trench. The cost of back filling was less than 4 cents per cu. yd.

In ENGINEERING-CONTRACTING, June 3, 1908, p. 341, there is described a method of

digging a trench in quicksand by using a centrifugal pump, the cost of the labor on the work being very low; but, in order to use the centrifugal pump, sections of the trench 150 ft. long were built into watertight coffer dams, and then excavated. Both of these methods of trenching were economical and a comparison of them is of interest, but the great contrast is in the sheeting of the trench. Then, too, the pipe work in a trench that has been unwatered by points is done in the dry, while in the other ditch the bottom is always wet. Where cement joints are used this is an important consideration.

In unwatering ground with points, the points should not be driven below the full

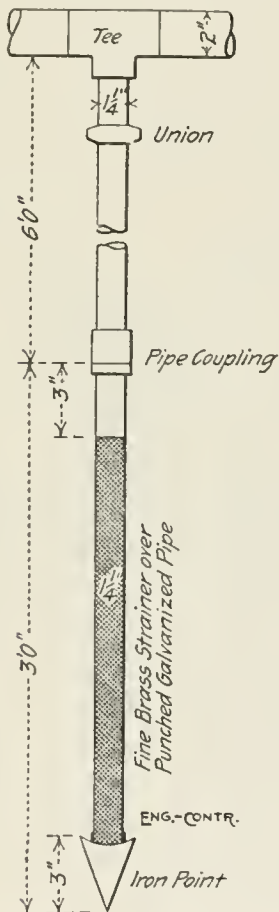


Fig. 2—Sketch of 3-Ft. Pump Point.

depth of the excavation at first, as larger pumps and more points are needed, as the area of ground unwatered is much greater than by driving the points down only a foot or two, and sinking them as the excavation progresses. With the points nearer the surface the ground is kept dryer and in case of hard rains, the rain water is carried off quicker. In Fig. 2 we show a sketch of a 3-ft-1 1/4-in. pump point. Such points have been used for years in obtaining water for consumption from sandy, sub-soils, and they have likewise been used for unwatering earth to be excavated, from time to time, but engineers and contractors have neglected to tell in the technical papers of their successful use.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Method and Cost of Repairing Macadam Roads by Scarifying and Rolling Instead of by Patching.

BY E. A. HACKETT, M. E., M. INST., C. E.*

[This excellent article appeared originally as a pamphlet, published by the Irish Roads Improvement Association. At the end of the article will be found additional information furnished to us by the author, including rates of wages. Wages in Ireland are about one-third as great as wages in America.—Editors.]

It has occasionally been said by way of apology for Irish roads that their inferiority is not due to any want of care or knowledge on the part of local authorities, but to something in the climate, soil, or other conditions which render inapplicable to Ireland the methods employed in other countries.

The following pages afford ample proof that in the case of steam rolling, with the use of proper materials, intelligently and carefully applied, excellent and economical results are obtained in this country. These deal specially with steam rolling only, and do not touch, except to a very slight extent, on the construction of the foundations, drainage or other attributes of a good road, varying alike as they do according to the nature of the soil, the traffic, and other conditions. Although steam rolling, properly carried out, will on any road give better results, both from the point of view of the rate payer and the traveler, than those obtained on the old patching system, the best results can naturally be obtained where the other conditions are appropriate.

There are many very desirable ways which can be suggested of improving Irish roads. Of all these steam rolling is the most effective, and not merely so, but far and away outstrips every other suggested improvement in importance. It is immediate in effect, giving in many cases immediate relief to the rates, and is universally appreciated. It greatly increases the comfort and ease of traveling and carting, enables a 25 per cent more loading to be carried and reduces the cost of carriage, saves the feet of horses and cattle, saves wear and tear of vehicles, brings tourists, etc.

Some reflection will enable one to realize the superiority of rolling in stones over the ordinary patching system. By patching, a smooth surface cannot be procured, the result being that the water lodges in numerous depressions and tracks, eventually soaking into and softening the road and its foundations. With the smooth and nearly impervious surface obtained by rolling, the water runs off the road like off the side of

a roof. The greatest practical difficulty met with in maintaining good roads—although few people except surveyors realize it—is not the amount of traffic, as is generally supposed. This is instanced by the fact that on the slope of a hill and on cross roads, where the traffic is double that on other parts of the road, the surface is usually sound and smooth. The great difficulty is the tendency of a road to get tracked by the wheels. This evil is aggravated by every additional inch in the height of the center of the road for the purpose of throwing off the water. Consequently in maintaining roads by patching it is necessary to keep the center of the road no more than 2 to 3 ins. higher than the sides. This height is too low for effectually draining off the water. The cause of tracking is the tendency which horses and vehicles have of following in a track previously marked by another vehicle on a soft or dirty road. Here the roller comes in. The rolled surface is so hard and clean that a vehicle leaves no mark on it, and the traffic naturally distributes itself all over the road, a result obtained which baffled all the old race of road makers. In addition we find that without causing tracking the center of the road may safely be raised to from 4 to 7 ins., thus assisting in the disposal of the water. A rolled road dries up in half an hour after a heavy shower. Again, if patches of stones consolidated by wheel traffic be examined, it will be found that a large proportion, probably one-third, will be found to be broken into fine dust and rendered useless. The surface, if examined with a pick and shovel, will be found loose in texture, pervious to water, and composed of stones broken up fine, partly mud and partly stones, and presenting a surface incapable of resisting traffic. On the other hand, a rolled surface will be found composed of stones compacted together like a tessellated pavement, and presenting a smooth, hard surface to the traffic, and to a great extent impervious to water. Further, with a rolled surface there is no bumping of wheels on and off loose stones, into and out of ruts, thus making fresh holes and enlarging existing ones. The writer is of opinion that one-third of the materials used in patching is wasted by being broken up into dust and scraped or swept off as mud and dust—a heavy penalty to pay for an antiquated system. Further, that a large proportion of the mud scraped off patched roads comes not from the surface but up from the foundations, the stones sinking down to take its place.

As an example of such waste of stones, the writer found in sinking holes in a very

* County Surveyor, Co. Tipperary, S. R.

bad main road that there were 2 ft. of broken stones in it, a quantity which, if properly applied, would have been sufficient to maintain the road for 20 years; and this, too, not a solitary case.

One of the greatest savings effected by rolling a road is due to the diminished amount of scraping and sweeping. In actual work it is found that out of every 1s spent in repairs that 4d to 6d goes in cleaning the surface. Such expenditure puts nothing into a road and is so far waste. With rolled roads this expense in cleaning is reduced by 50 to 70 per cent. In urban districts the proportion of expense in cleaning is twice as much, and leaving out entirely the desirability from a sanitary point of view of having an impervious surface, the saving in this respect is much greater than on country roads. Another saving is in the diminished cost of stone breaking, as the stones can be used to a larger gauge.

When rolling commenced in the Co. Tipperary S. R. there was considerable hostility to the work. The customary bad prophecies foretold that bridges and gulleys would be broken, that the rollers would frighten horses, that the roads would be dangerously slippery in wet weather and frost, that the roads would not stand the first winter's frost and be broken up, etc., *ad libitum*. These were all erroneous. The rural districts at first passed money for the work as a kind of grudging concession, and some not at all. There was extreme hostility on the part of individuals. After two years' experience all this changed. Every district came into line. The competition between the councils for their proper share of the work became keen. So far as is known, every councillor in the county is in favor of the work, which is also much appreciated by the public. The first roller educated the people, so that there was little or no opposition to the purchase of the additional rollers subsequently bought.

The first question which will be asked by those responsible for county administration is, "Will rolling pay?" Afterwards it has been found in every county the collateral advantages will so outweigh that initial consideration that councillors will say, as they do in the Co. Tipperary S. R., that it is well worth a couple of pence in the pound extra to have rolled roads. Not that rolling has led to any increase, as for the year 1903-4 the cost of the roads was less than the average in the grand jury time. To answer this important question, the following tabular statements have been prepared, Table I showing how the cost works out for different classes of roads. In preparing the table it has been assumed that the money is borrowed at 3½ per cent interest for such term of years as the different roads are estimated to last, and repaid by equal installments of principal and interest during that time. The prices of Irish roads being usually by the statute perch (16½ lin. ft.) that familiar unit is taken. A sum for annual maintenance

after rolling is included. The expenses of repairs and depreciation of the machinery are taken at 10 per cent per annum, which is the customary figure. The cost is calculated per cubic yard; i. e., about one and a fifth tons. The cost of the materials used is taken as follows:

	Per cu. yd.	Per cu. yd.
Quarrying and breaking.....	1s 10d	\$0.46
Haulage	7d	0.15
Spreading, watering and sweeping	6d	0.12
Recarting stones, removing scarified materials.....	5d	0.10
Surface damage to quarries..	2d	0.04
Rolling	8d	0.17
Contingencies and profit.....	5d	0.10
Total	4s 7d	\$1.14

mediate classes of roads intermediate thicknesses.

At the end of the term of years given as the life of each road, the condition of affairs will be that the center of the road, but not the sides, will have worn down. Rerolling will then be necessary, but under very different conditions. The sides being still sound and there being a considerable body of the rolled-in stone still in the road, a lesser width need only be rolled as well as a thinner coat of stones. Table II is now given to exhibit this second rolling. It will be noted that now the second rolling is about to be carried out, the road may be considered to have arrived at a permanent stage as respects cost. This cost will be recurrent when the time for each subsequent rolling takes place. The cost of the materials has in this table been taken at

TABLE I.

Original cost.	Cost of stones and rolling.	Cubic yards used.	Per Perch.		Repairs and depreciation machinery.	Totals of cums 1, 5 and 6.	Width of road rolled.	Estimated life of road, years.	Saving per perch effected.
			Annual repayments.	Average subsequent maintenance.					
1	2	3	4	5	6	7	8	9	10
s. d.	s. d.		s. d.	s. d.	s. d.	s. d.			d.
2 0	10 8	2¼	1 9	0 5	0 2	2 4	12	7	4*
2 6	10 8	2½	1 9	0 5½	0 2¼	2 4¾	12	7	1¼
3 0	12 7	2¾	2 4	0 6	0 2½	3 0	14	6	0
3 6	12 7	2¾	2 4	0 6½	0 2¾	3 1¼	14	6	5
4 0	14 11	3¼	3 3	0 7	0 3	4 1	15	5	0
4 6	14 11	3¼	3 3	0 8	0 3¼	4 2¼	15	5	4
5 0	16 0	3½	3 6	0 9	0 3½	4 6½	16	5	5½
5 6	16 0	3½	3 6	0 10	0 3¾	4 7¾	16	5	4
6 0	18 4	4	4 0	1 0	0 4	5 4	17	5	8

*Loss.

The widths laid out in this table to be rolled will at first sight be deemed insufficient. Account must, however, be taken of the fact that there is a foot to 18 ins. at each side of every road taken up by the steep slope to the water channel. Further, it will be found by observation of traffic that one in every 10 to 20 wheels only travels over the space within 2 to 3 ft. of the water channel; also that the new layer of stone is neatly dovetailed into the old surface of the road at the side, giving the whole the appearance of being rolled. When these considerations are taken into account it will be found that the widths mentioned are, as has been found in practice, ample to accommodate the traffic.

The results as exhibited in Table I are satisfactory as effecting a saving of from 1d to 8d per perch on all roads except the 2s roads.

The thickness of materials rolled in is about 5 ins. in the center of the 6s a perch road, thinning out to 1½ ins. at the sides, and for the 2s a perch road 3 ins. at center and 1½ ins. at sides, and for the inter-

5s per cubic yard instead of 4s 7d as in Table I, to allow for extra scarifying which will be required and for breaking the stone to a 2-in. gauge.

This result may be considered most satisfactory from a mere money point of view.

The question will now be asked, "How do these estimates tally with actual experience?" For reply, in Table III is given examples out of many cases of work actually carried out, giving the actual figures of cost, etc., for the first rolling in the County Tipperary S. R.

Some of these were rolled before the system of borrowing came into operation, and the figures are based upon the assumption that the money was borrowed, and the life of each road is taken as in Table I, as verified by four years' experience. All except the Ardmayle main road have several years of life still before them—from 2 to 1—before rerolling is required.

This result from actual practice shows that the saving as estimated in Table I is

somewhat underestimated and not up to the result actually achieved.

Having regard to the unprecedented wet winters of 1903 and 1901 and the wet 1903 summer, these two years in calculating the life of rolled roads should be counted as equivalent to three ordinary years.

The subsoil of the roads in Co. Tippe-

ence in Co. Tipperary S. R., with a large direct labor system, is that a man will do three times the work with twice the efficiency that he will do with an ordinary scraper. All depressions occurring in a rolled road must be carefully filled. This should be done in wet weather and only then. In such weather these depressions

materials which are suited for road repairs with the ordinary patching system may be used for rolling. Whinstone and basalt and hard granites are of the best class, limestone and limestone gravel, when of good quality, produce probably the most comfortable country roads, although not hard enough for very heavy traffic. Both of the latter, as well as a tough sandstone and a metamorphosed shale, have been successfully used in the Co. Tipperary S. R.

In connection with the use of gravel, the writer confirms from his own experience the practice of the English surveyors that it is desirable in order to produce good work that the stone should be graded in size and quality, each particular size and quality being used by itself on a separate length of road. The size found most suitable for use as respects broken stone is to pass through a 2½ in. ring and as respects gravel to pass through a 2 in. screen. In the latter case the gravel passing through a ¾ in. screen should be rejected. The larger gravel stones should be broken.

As between the same qualities of stone, that which breaks into the more cubical shape is best as opposed to that which breaks flat. The flat pieces on the surface are apt to work loose and are liable to be broken up too much in rolling. So far as possible, even at an increased price, the best quality of stone available should be used, as it costs only the same amount to roll it in and the result is better.

As to the size and weight of rollers to be used, they are usually made in three sizes—10 tons, 12½ tons and 15 tons. The writer believes the 15 ton roller to be the most economical. As compared with the lighter types, the cost is very little more and not in proportion to weight. It requires the same attendance, very little extra fuel, and performs once and a half the work a 10 ton roller does. Objection is made to the extra weight that there is more danger of breaking gulleys, etc., but this objection is not tenable, as the weight is distributed over a greater width and produces no more pressure than a light roller. For town work, however, the conditions are different. A wide roller, like a 15 ton, cannot move about from side to side in narrow streets, and consequently leaves seams in the surface. For such places one of the lighter weight and narrower roller path is desirable.

A rolling equipment should consist of one roller with scarifier—no independent scarifier has so far proved efficient—one traveling and sleeping van, and two water carts. For country work a sleeping van is essential, as otherwise the roller must be brought to some town or village at night or left by itself on the side of the road at the site of the work; the men would otherwise lose time coming to and returning from work, time would be lost getting up steam from the cold every morning; hasty getting up of steam is bad for the boiler, and lodging money for the men is saved. Also

TABLE II.

Original cost.		Per Perch.		Cubic yards used.	Annual repayments.		Average subsequent maintenance.	Repairs and depreciation machinery.	Totals of Columns 4, 5 and 6.	Estimated life of road, years.	Saving per perch effected.				
		Cost of stones and rolling.													
		2	3	4		5		6		8		9			
s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	d.			
2	0	8	0	13	5	1	4	0	5	0	1¾	1	9¾	7	2¼
2	6	8	0	13	5	1	4	0	5½	0	1¾	1	11¼	7	6¾
3	0	9	0	14	5	1	8	0	6	0	2	2	4	6	8
3	6	9	0	14	5	1	8	0	6½	0	2	2	4½	6	13½
4	0	11	3	2¼		2	6	0	7	0	2½	3	3½	5	8½
4	6	11	3	2¼		2	6	0	8	0	2½	3	4½	5	13½
5	0	12	6	2½		2	9	0	9	0	3	3	9	5	15
5	6	12	6	2½		2	9	0	10	0	3	3	10	5	20
6	0	15	0	3		3	4	1	0	0	3¼	4	7½	5	17½

rary varies greatly; from rock to gravel, yellow clay and peat.

The best subsoil gives the best result. Some of the roads which have been rolled had no proper foundations, others were properly founded.

The maintenance of roads subsequent to rolling is of importance. A rolled road if not properly cared for will not realize its

can be seen by the small pools of water lying in them. A man with a cart or wheelbarrow should be sent over the road and such depression neatly filled with a shovelful or half a shovelful as may be required, only such quantity of materials being used as will fill the depression. The best material for this purpose is fine hard gravel passing through a ¾ or 1 in. screen.

TABLE III.

1 Name of road.	2 Date when passed for steam rolling.	3 Original cost per perch.	4 Expenditure per perch.	5 Annual repayment per perch.	6 Average subsequent maintenance per perch.	7 Totals of columns 5 and 6.	8 Saving per perch.	9 Present condition.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	
New Birmingham								
M. R.....	April, 1900	2 6	11 10	1 10	0 6	2 4	0 2	Good.
Ballinilard M. R.	April, 1901	3 0	11 8	2 2	0 8	2 10	0 2	Good.
Ardmayle M. R.	April, 1900	3 6	11 6	2 0½	0 9	2 9½	0 8½	Good wear
Newton Anner								ing.
M. R.....	April, 1900	4 6	11 6	2 6	0 10	3 3	1 2	Very good.
Rathman M. R.	April, 1901	5 6	13 8	3 0	0 11	3 11	1 7	Very good.
Silverspring	1898	2 0	10 0	1 8	0 4	2 0	0 0	Very good.

full life in good order. Soft spots invariably turn up, and these, unless treated skillfully, will hold water and develop rapidly. The road must be swept both in wet weather and when dusty to prevent tracks. And here it may be remarked parenthetically that sweeping with coarse brushes is far too infrequently practiced. The experi-

In lieu of this fine hand-broken stone to pass through a 1 in. ring, or screenings from a stone breaking machine are suitable. In any event the material used for this purpose must be as hard as that originally rolled in, otherwise it will be crushed into powder by the traffic.

It may be taken for granted that any ma-

spare parts for the roller have to be kept and a coal bunker to hold a supply for four to five days can be fitted. For summer work two water carts are required, and summer rolling produces by far the best work. In cases even two carts have proved insufficient. The carts should be provided with a box pattern spreader, pipe outlet for filling water tank, a pump and 15 ft. of armored suction hose.

The following points should be attended to. Instructions are issued by the makers respecting the management of rollers, and the points referred to are to be taken up as supplemental to these. Use all round coal of good steam quality, damp down fires at night to save time in morning and to avoid straining boiler by rapid heating. Roll with tail of roller down hill to keep water in boiler over fire. Keep the following spare fittings: Two screwjacks, spare sets of mudhole and manhole rings, gauge glasses, two sets of scarifying tines, metal for running worn bearings; attend to tightening up all bolts frequently; use soda in tank with hard water; purchase this broken, chips from it would injure eye; use cylinder oil, use good, thick quality of lubricating oil, provide duplicate means of filling water, usually pump and injector; keep set of blank flanges for pump and injector so that engine can work while pump or injector is being repaired; use plug with fusible rivet for boiler; keep a supply of packing, etc.; insure boilers against explosion, if only for the benefit of the periodical inspection by skilled inspector; insure men against accidents. Get fortnightly returns of work done by each roller. Roll materials from side to center. Roll in lengths of 100 yds. to lessen time lost in reversing. Run over each day's length rolled on the next succeeding day to finally consolidate. In case road purges in rolling leave off at once and finish off when road dries. Use no binding if possible, and in any event none until stones are rolled fairly smooth, and then sparingly. Do not permit roller over any iron bridge until satisfied of its safety. Avoid rolling close up to old retaining walls. Get roller conducted through towns by town officials to avoid gas pipes and defective drains. Divide road to be rolled into short sections and prescribe the amount of stones to be used on each section to avoid materials being unequally used on parts of road. Roll roads upon which there is a scarcity of water in the winter. Fortnightly cleaning out of boiler should be on Mondays, when boiler is cold. Fit in cleaning out days to match fair and market and and race days when little work can be done.

The work done by a 15 ton roller varies from 120 to 210 perches in length of a road 12 to 16 ft. wide rolled per fortnight. This represents the consolidation of from 360 to 630 cu. yds. of stone per fortnight, or 33 to 60 cu. yds. per day actually worked (the stone being measured loose as piled along the road), one day per fortnight be-

ing lost in cleaning out boiler. An average of 160 to 180 perches per fortnight may be considered as a satisfactory amount of work, representing 13 to 15 miles per annum. The greater amount of work will be done in the winter, as the softness of the roads permits the stones to bed in more rapidly. One the other hand the work done in dry weather is much superior, so the advantage gained by winter rolling is more apparent than real.

Before materials are spread to be rolled in, the surface of the road should be lightly scarified so as to permit the fresh stone to bed into the old surface. This is always necessary when the road is dry and hard, unless in such cases as the surface is so thin and worn that the scarifying tines would reach the soling of the road or the foundation upon which it is laid, and unless the road is very soft from continued wet weather. A short experience will enable the surveyor to discriminate such cases. Watering 12 hours previous to scarifying will be found to help matters considerably. When the road is out of shape owing to being too high in the center, having sides higher than the center or sidelong or too narrow, the road must be scarified so as to bring it into proper shape, the scarified materials being shifted so as to produce that result for the proper width. Great economy of materials can be effected in this way. At times large quantities of materials can be so procured to supplement the fresh stones to be used. The fresh stones when spread should be rolled dry until they are fairly consolidated, after which they should be well watered and rolled to an approximately smooth surface. Water should be economized by being dammed up in the water channels and not run to waste. Concurrently with the watering, two or three men should keep sweeping the road so as to brush in the debris produced by the rolling into the interstices of the stones. Then and only at this stage binding materials should be used and well brushed into the stones. The use of binding is of importance, and its use will make or mar the road. Road scrapings are frequently used, and although they enable a finished appearance to be given to the road with less rolling than otherwise might be deemed necessary, the ultimate effect is injurious. The use of road scrapings reduces the solidity of the road, renders it pervious to water, causes mud in wet weather, and enables frost to take a greater effect upon it. The best materials for binding are very fine gravel or fine chippings from a stone breaker, and the next best, sand. With binding of poor quality it should be used most sparingly, say three or four shovelfuls to the perch, but with material of a better quality it may be more freely used. It is fatal to success to use large quantities of binding, and particularly to mix it with the stone to be rolled before the latter is fairly well consolidated. If used in the latter way the

road soon sinks into pockets and the entire effect sought is soon lost. The stage at which the rolling is sufficiently complete is more or less a matter of experience, but it may be said to be completed as soon as the eye cannot detect the isolated stones and when the whole surface appears to be uniform and smooth. If procurable, fine gravel or screenings from a stone breaker should be scattered over the surface after rolling. This prevents the traffic from licking up the binding out of the stones and besides the gravel gets compressed into the joints of the stones, rendering it most compact.

The height of the center of the road when rolled should be as follows:

For a road rolled 8 ft. wide, height of center to be 3¼ ins.

For a road rolled 10 ft. wide, height of center over sides to be 4 ins.

For a road rolled 11 ft. wide, height of center over sides to be 4¼ ins.

For a road rolled 12 ft. wide, height of center over sides to be 4½ ins.

For a road rolled 13 ft. wide, height of center over sides to be 4¾ ins.

For a road rolled 14 ft. wide, height of center over sides to be 5 ins.

For a road rolled 15 ft. wide, height of center over sides to be 5½ ins.

For a road rolled 16 ft. wide, height of center over sides to be 5¾ ins.

For a road rolled 17 ft. wide, height of center over sides to be 5¾ ins.

For a road rolled 18 ft. wide, height of center over sides to be 6 ins.

For a road rolled 19 ft. wide, height of center over sides to be 6¼ ins.

For a road rolled 20 ft. wide, height of center over sides to be 6½ ins.

The slope of the road from center to sides should be neatly curved and not flat.

In streets of large towns and in the suburbs of cities the rolling of roads is frequently very disappointing in its results, owing to the streets or roads not having been originally properly constructed. To enable a road to sustain traffic of a heavy nature a road should have a proper foundation, whether it is to be rolled or not. In the pamphlet recently issued by the Irish Roads Improvement Association and written by Thomas Aitken, Esq., Assoc. M. Inst. C. E., the method of making a road with proper foundations is fully described and illustrated. That method consists of laying a foundation of a layer of large stones, broken through a 3 in. to 4 in. diameter ring, varying in thickness at the center from 9 ins. to 12 ins., according to the severity of the traffic, and consolidated with a roller. This is covered with a cushion of sharp sand or cinders, 1 in. to 2 ins. thick, after which a layer of stones from 4 to 6 ins. is rolled in the ordinary way. In reconstructing a road in this way the drainage, which is most vital, must not be neglected.

Rolling in patches of the size customary in repairing by the patching system is not

satisfactory either from an economical or efficient point of view, especially so on a road previously rolled. The sites of the patches cannot be scarified without enormous expense, the stone is crushed, and the road left uneven. A road not previously rolled, if taken in very wet weather when the road is soft, can be made an indifferently good job of, but at an excessive cost, as the roller is running idle most of its time.

Upon the assumption with present experience (1901) that it is good policy to roll all roads costing 2s a perch and upwards, the number of rollers necessary for any county can be calculated. In the Co. Tipperary S. R. there are 268 miles of roads of this class. As, however, it will be found that other roads costing less than 2s will, on account of being important thoroughfares, in practice be rolled, a further 100 miles may be added, making 368. Upon the assumption that each road will require rolling once in every six years, four 15-ton rollers will be found sufficient for 368 miles and three for 268.

[The wages paid in Ireland on road work are as follows:

Common laborers, per day.....	\$0.52
Foremen, per week.....	6.00
One horse cart and driver, per day.....	1.25
Engineman on roller, per day.....	1.25
Flagman and timekeeper, per day.....	0.87

Coal costs \$5.50 per long ton at the railway station, and a 15-ton roller consumes one-third ton per day.

All quarrying and breaking of stone was done by hand in the work above described.

Mr. Hackett states that in Tipperary county there are 1,500 miles of macadam roads, of which 300 miles are main roads. The population is 90,000, and the area of the county is 1,000 sq. miles. The traffic is not severe, practically all in one horse carts carrying loads of 1 to 1½ tons on a pair of wheels.

To convert the costs given in Table 1, bear in mind that a shilling (s) is 25 cts., and that there are 12 pence (d) to the shilling. There are 320 perches per mile. A stretch of road 16 ft. wide and one perch (16½ ft.) long contains practically 30 sq. yds.

From Table I it can be deduced that the cost of repairing a macadam road 16 ft. wide is about \$260 per mile per annum, there being 0.12 cu. yd. of broken stone used per sq. yd. of road for each resurfacing every five years, which is equivalent to 1,120 cu. yds. of stone per mile every five years, or 224 cu. yds. per mile per annum. Since the steam roller averaged about 50 cu. yds. of stone compacted per day, it is a simple matter to estimate the cost of such repairs under American conditions as to wages.

For comparative figures of cost of repairing macadam, the reader is referred to Gillette's "Handbook of Cost Data" and to Gillette's "Economics of Road Construction."—Editors.]

Water-works and Sewer Section

Note: This section is devoted to methods and costs of constructing sewers and water-works. It will cover the construction work for all details of water supply and sewerage, including sewage purification and water filtration.

Method and Cost of Moving Steel Forms for an 8 ft. Concrete Sewer.

On Fourteenth avenue, Brooklyn, an 8 ft. reinforced concrete sewer is being built. The features of this work that is worthy of special notice is the forms used to support the arch during construction.

As will be seen in Fig. 1, these forms are self-supporting, requiring no interior bracing. In consequence of the absence of interior bracing, it is possible to collapse a section of forms and bring it from the rear to the front on a small car, as shown in

section is fastened tightly to its rear neighbor, and the car is run back to get the next section.

On this particular sewer the forms are made in sections 8 ft. long, and, although the track upon which the car runs is a wooden track, two workmen readily push the car with its load. Due to the fact that the longitudinal ribs of the forms are of corrugated steel, they are exceedingly light, and the forms are therefore handled with ease.

Three men constitute the whole force

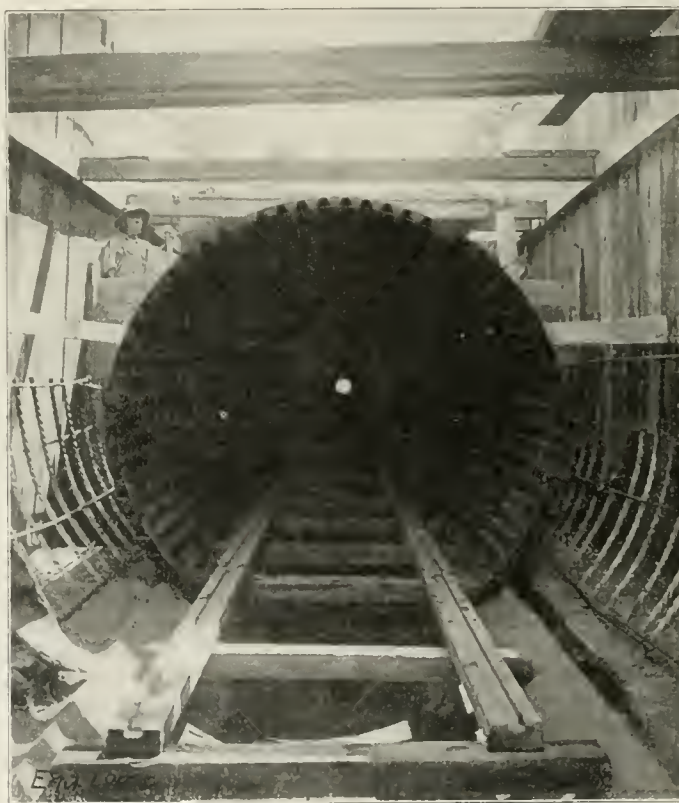


Fig. 1—Eight-Foot Forms in Place.

Fig. 2. The reader will note that the lower part of these forms is hinged, so that this part can be folded up while the section is being transplanted. When a section of the forms has been brought forward, the car that supports it is "jacked up" by means of any convenient plank used as a lever, and wooden blocks are placed underneath the car to hold it. Then the workmen expand the forms latterly by pulling up on the rope (shown in Fig. 2), which is fastened to a toggle. The lower hinged parts of the form are then swung down until they rest on the cross ties as shown in Fig. 1.

By means of turnbuckle clamps this form

required to knock down and shift one of these large 8-ft. sections. A representative of this journal timed the men and found that they readily shifted an 8-ft. section in half an hour, including all the time of unbolting, shifting, and bolting it up again ready to support the concrete arch.

The practice is to move four sections forward successively, thus providing for 32 lin. ft. of sewer. Since the sewer arch contains 1.4 cu. yds. per lin. ft. these 32 lin. ft. require 45 cu. yds. of concrete. Three men, therefore, shift interior forms for 45 cu. yds. of concrete in 2 hrs. Hence 6 hrs. labor at 17½ cts., or \$1.05, covers the cost of shifting these interior forms.

which is less than $2\frac{1}{2}$ cts. per cu. yd.

The total cost of labor on forms is, of course, considerably in excess of this, since the outside wooden forms and the wooden forms for the invert require much more labor. However, the total cost of labor on the forms of both invert and arch has averaged only 50 cts. per lin. ft. of sewer. Since there are 2.2 cu. yds. of concrete per lin. ft. in both invert and arch, it will be seen that the cost has been less than 23 cts. per cu. yd. for all labor on forms. This remarkably low cost is being steadily reduced.

The engineers will not permit forms to



Fig. 2—Telescoping Eight-Foot Forms.

be struck until 72 hours after concrete has been placed; but, whatever the requirement, the contractor is able to meet it with ease, by simply providing the necessary number of 8-ft. form sections. As many or as few of these sections can be brought forward as the progress of the work may require, and without interfering in the least with the sections already in place.

The contractor for this work is P. J. Murry & Co., and the forms are furnished by the Duralite Co., of 42 Broadway, New York City.

On Aug. 1 there were in force contracts for work on the New York State Barge Canal amounting to \$26,265,158, and extending over 152.48 miles of canal.

The aggregate mileage of the railways of the United States, including all tracks, on June 30, 1907, was 327,975.26 miles.

Reinforced Concrete Block Constructions for Culverts and Sewers.

Possible advantages to be had in constructing small sewers and pipe culverts of separately molded concrete blocks have led a number of engineers to devise types of concrete block construction for such work. As inquiries have recently come to us regarding the practicability of using molded blocks for sewer work, we give here two forms of block construction which we know to have been developed with unusual care. We are not informed whether either of these constructions has

flat and the other end formed with a projecting lip on the intradosal side. This projecting lip closes up against the flat end of the block ahead, forming a groove three-quarters around the sewer. In setting the blocks, this groove is located directly in line circumferentially with the reinforcing rod in the invert block. By this arrangement the reinforcing bars placed in the groove are in line with that in the invert block and the inside bar is connected up and made continuous around the sewer. For longitudinal reinforcement flat iron straps are embedded in the radial joints as shown by Fig. 1.

A 2-ft. long section of this sewer of the dimensions shown by Fig. 1, withstood without deflection or cracking a test load on top of 9,125 lbs.

The claims made by the inventor for the construction are:

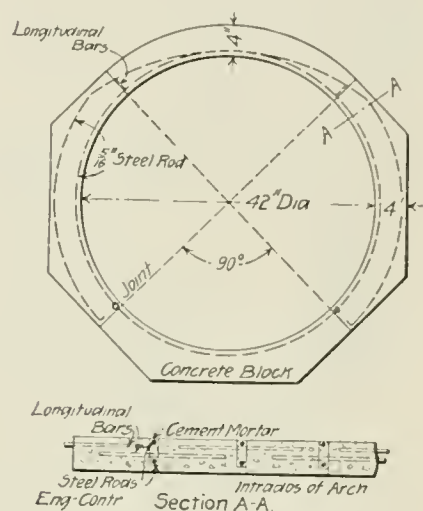


Fig. 1—Reinforced Concrete Block Sewer Construction.
W. C. Parmley, Inventor.

been used in actual sewer building, but, as will be noted, test lengths have been built and loaded to destruction with successful results. Both of these constructions are reinforced.

Parmley Block Sewer.—A reinforced concrete block construction for sewers devised by Mr. W. C. Parmley, M. Am. Soc. C. E., is shown by Fig. 1. The idea of the design is to have the joints occur where the bending moments are minimum, which, in the circular section shown, is at the 45 degree quarter points, making a four-block construction. For egg-shaped sewers the arrangement would, of course, be somewhat different.

The bottom or invert blocks are molded with flat ends forming butt joints which are made with mortar. The reinforcing rod is molded into the block midway of its length, which is 1 ft., with its ends projecting and bent to form eyes. The haunch and crown blocks have one end

(1) Economy.—(a) On account of the thin side walls and the method of constructing the sewer, a less quantity of excavation is required than for either a brick or a vitrified pipe sewer. (b) The alignment and grade can be easily and accurately secured by laying the invert blocks in advance of the building of the remainder of the sewer, and they can always be kept built close up with the finished portion of the excavation. (c) No centering is required for this type of sewer—only a light removable template to assist in accurately adjusting the blocks. The arch at all times is self-sustaining. (d) Backfilling can begin as soon as the arch is completed, which ought not to be done in case of a brick sewer where from one-fourth to one-third of the entire mass of masonry is soft mortar. (e) Cheapness of the material used, as concrete is the least expensive building material at the present time. (f) The blocks can be made anywhere, even alongside the sewer trench. Freight and teaming charges are therefore avoided, which can not usually be done when bricks are used. (g) Sewer can be

Railway Section

Note: This section is devoted to methods and costs of constructing railways. It will cover road-bed and track construction, contractor's plant and organization, surveying methods and permanent way structures.

Method of Treating Ties With Creosote at Galesburg, Ill.

The Chicago, Burlington & Quincy Ry. has built a plant for treating ties at Galesburg, Ill. The plant is situated on a tract of 80 acres with a space for tracks having a capacity of 2,000,000 ties, although at present there are tracks for a storage of only 1,000,000. For fire protection in the yard, hydrants are spaced 300 ft. apart, being supplied with water from a 100,000 gallon storage tank, fed by a well 1,300 ft. deep. The tracks in the yard are laid with three rails, as narrow gauge cars are used to deliver the ties to the retorts.

The plant was located at Galesburg as it is the connecting point of the Burlington lines with the south, the principal source of the supply, and on this part of the system there are always available stock cars for the shipment of the treated ties. Box cars cannot be used for this purpose on account of the odor which is retained in the cars when loaded with creosoted timber.

The main building is 152x115 ft., divided into three rooms, one containing three retorts, another the engines and tanks, the third being the boiler room. There is also a test room, fitted up for treating four ties. The building is of reinforced concrete throughout. The window sashes are of metal, glazed with wire glass, while the doors are all covered with sheet metal.

The retort room is the full length of the building and 38 ft. wide, the retorts being 132 ft. long and 6 ft. in diameter, made of 3/8-in. steel, furnished by the Allis-Chalmers Co. Each has a capacity of 650 ties, while the plant treats 6,000 ties in 24 hours.

There are three 150-h. p. boilers, one being for emergencies. There is no chimney, induced draft system being used. The engine room, 30x115 ft., contains an Ingersoll-Rand compressor, with a capacity of 525 cu. ft. of free air per minute, a Knowles fire pump, three Knowles pressure pumps, one Knowles oil pump and one Battle Creek vacuum pump. There is also a small electric light plant in this room.

The tank room, 39x50 ft., contains a 25,000-gallon steel working tank and a 100,000-gallon steel mixing tank for creosote. On the outside, close to the main building, are the storage and measuring tanks, one 500,000 gallon steel tank for creosote storage and two 5,000 gallon steel tanks for measuring creosote, two 50,000 gallon wooden tanks for zinc chloride and one 25,000 gallon iron storage tank for zinc

chloride. The two steel outside tanks are arranged for heating with steam coils.

The plant is arranged with its pipe connections between pumps, tanks and retorts, so that the straight zinc chloride process, or the two, known as the Card process, may be used on one retort or on all three. In the Card process, which is a modification of the Rutger, the zinc chloride and creosote are continuously agitated under pressure by centrifugal pumps, and ordinary coal tar creosote can be used. Each retort is connected with an electrically driven centrifugal pump, which forces the liquid in at the bottom and exhausts it from the top of the retort. The vacuum in retorts is obtained by a Baragwauth barometric condenser, with an auxiliary air pump 6 1/2 x 12x12 ins. having a connection with the air chamber of the condenser. The condensing pipes are placed on the roof of the engine room.

The Rutger process has been used in Germany, but it requires a creosote having special qualities and is expensive. In the Allardye process the zinc chloride is put in first and then the creosote, while the Ruping process aims to reduce the expense for creosote by first filling the wood cells with compressed air and then coating them with creosote.

Seasoned ties are treated directly, but if green they are first steamed under pressure of 5 to 20 lbs. from 1 to 2 hours. The sap is blown off every 15 to 30 minutes. With the Card process a vacuum of 27 to 28 ins. is held on the retort for an hour, and, with the vacuum still on, the mixture of zinc chloride and creosote is run in by gravity, entirely filling the retort, and requires about 18,000 gallons. The liquid is heated to 180° F., and at this temperature the two ingredients do not separate as rapidly as in a cold solution. The centrifugal pumps are then started and the liquid is circulated at the rate of 2,500 gallons per minute and the whole charge is changed every 7 or 8 minutes. At the same time the pressure pumps are started and pressure gradually increased to 150 lbs. and held at that for 2 to 4 hours, or until a sufficient amount of the liquid is absorbed by the timber.

The pressure pumps are connected to the 5,000 gallon measuring tanks which have gauges operated by floats, and in this way the volume of liquid forced into the timber is known. When the gauges show a sufficient amount the pressure is released and the remaining liquid is forced back into the mixing tank. Then a vacuum of 24 to 28 ins. is created and held for an hour, taking out all surplus liquid into

the underground tanks, where it is allowed to settle and then returned to the mixing tank. This last treatment is for the purpose of removing the surplus creosote remaining on the surface of the ties, so they can be handled comfortably, and 500 gallons saved from each retort.

The retort door is then opened and the cars withdrawn by wire cable operated by electric motor and switched to the platform, where they are loaded directly for shipment. Each tie is marked with a short thick nail having the year of treatment on its head. The ties are loaded by the Anzier loader at a cost of 25 cts. per tram.

An approximate cost of the new plant is as follows:

Land	\$28,000
Tracks	50,000
Sewers	5,000
Well	6,000
Platform	3,000
Building	30,000
Three retorts	30,000
Tanks of all kinds	10,000
Pipes and valves and labor	20,000
Pumps	6,000
Boiler and settings	5,000
Electric light plant	3,000
Mundy hoists	2,500

\$198,500

Thirty men are employed in the offices and plant, there being a chief engineer and chemist, 2 engineers and 2 assistant engineers for day and night, 3 sub-foremen and 2 motormen, besides the laborers.

The liquid used is a mixture of 17 per cent creosote and 83 per cent zinc chloride solution, the latter containing 3 per cent chloride and the rest water. The creosote has a specific gravity of 1.045 and contains about 35 per cent naphthalene and 5 per cent tar acid. The cost of creosote is 6 3/4 to 7 cts. per gallon.

The cost of treating a pine tie is estimated on the quantity of liquid required per cu. ft. of tie.

	Per cu. ft.
0.5 lb. dry zinc chloride @ 4 cts. lb.	\$.020
0.8 lb. creosote @ 3 cts. lb.	.024
	\$.044
A tie containing 3 cu. ft. will cost	3
	\$.132
Add for labor, fuel, supplies and supt.	.046
	\$.172
Int. and Depreciation	.015
Total	\$.187

This figure is the cost during the winter months. The cost is less in warm weather—probably as low as 16 cts. About 46 per cent of the ties treated at this plant are red oaks, and 35 per cent yellow pine, the rest being gum, elm, beech, birch, etc.

The plant was designed under the supervision of T. E. Calvert, chief engineer, and F. J. Creiger, who now has charge of the plant.

The Average Cost of Repairing Locomotives in America Compared with the Cost on the Northern Pacific, Together with Comments on Plant Depreciation and Repairs.

Ridiculous underestimates of depreciation and repairs of contractors' plants, and of machinery in general, are to be found in articles and books without number.

When an engineer knows nothing about depreciation and repairs—and, as a rule, he shares the common ignorance—he will, in all likelihood allow 10% for annual depreciation and repairs and let it go at that. In the majority of cases he will hit wide of the mark, for depreciation alone frequently is as high as 10%, and current repairs often exceed 20%.

In this connection it is well to point out that the word depreciation is improperly used by many engineers.

Depreciation may be defined as being that percentage of life lost by a machine each year. In this sense it is the reciprocal of the life of the machine. Thus, a machine having a life of 20 years has an annual depreciation of 5%. But the repairs and renewals of parts on that same machine may be 15% or more annually.

If an amortization fund is established to buy a new machine at the expiration of the life of the old one, it is clear that the percentage annually set aside for this purpose should be less than the annual depreciation, because the amortization fund will earn interest if invested. A machine having a prospective life of 20 years will be redeemed by setting aside 3% annually, if the amortization fund earns 5% interest compounded annually.

In appraising the value of the railways of the state of Washington, the managing editor of this journal gathered a considerable amount of statistical information both as to depreciation and repairs, which we shall publish from time to time.

If properly analyzed, the annual reports of the Interstate Commerce Commission contain valuable data on the repairs and renewals of rolling stock.

Let us take the 1906 report and deduce the percentage cost of repairs and renewals of locomotives. On page 26 of the report we find that there were 51,672 locomotives in service, of which 58% were freight, 24% passenger, 16% switching and 2% unclassified.

Page 29 gives the average weight (exclusive of tender) as 66 tons, for single expansion engines, which constitute 93% of all locomotives in service, and the average of all is only slightly in excess of 66 tons.

From the data as to train mileage on page 74 we deduce that each freight locomotive averaged nearly 20,000 miles per year, while each passenger locomotive averaged nearly 40,000 miles per year.

On page 96 the repairs and renewals of

locomotives are given as \$123,893,482. Dividing this by the 51,672, we get \$2,400 as the cost of repairs and renewals per 66-ton locomotive for the year 1906. In the year 1904 the corresponding cost was \$2,250 per locomotive of 60 tons weight.

A 66-ton locomotive costs about \$12,000 new, hence we see that the annual cost of repairs and renewals is about 20%.

What does this expression "repairs and renewals" include? Does it include depreciation? It does. Practically all the railways ignore the order of the Interstate Commerce Commission requiring them to charge to "repairs and renewals" the full value of every new locomotive used to replace an old one, for they charge to capital account the *excess* value of the new locomotive. This is perfectly proper, and is correct accounting, for it would be absurd to charge the full value of a new \$20,000 locomotive to "repairs and renewals" when it replaces a worn out \$12,000 locomotive. Only the \$12,000 should be charged to "repairs and renewals," while the \$8,000, or excess, should be charged to capital account.

Since the 20% cost for "repairs and renewals" includes depreciation, the next step is to ascertain what the depreciation amounts to annually. The Interstate Commerce Commission reports are of no assistance in ascertaining depreciation.

In studying the equipment records of the railway systems that operate in Washington, Mr. Gillette found that such a large percentage of locomotives were still in use at an age of 28 years that he selected 3.6% per annum as his allowance for annual depreciation. As a matter of fact, depreciation of locomotives has probably been greater than this in the past, due to the replacement of light locomotives by heavier ones, long before the light locomotives had rendered all the service that was in them. A life of 20 years for locomotives has probably been nearer the average, and it may possibly remain nearer the average than the assumed 28 years in the future, but there is strong probability that future increase in locomotive weight will not be so rapid as in the past. In any event, the railways are given the benefit of the doubt when 3.6% depreciation is assumed in appraisals that are to be used as a basis for rate making.

If locomotive depreciation is between 4 and 5% annually, and if we subtract this amount from the 20% (repairs and renewals), we have left 15 to 16% as the cost of locomotive repairs.

Now let us contrast these averages for the railways of the United States with the averages for the Northern Pacific Railway.

In the year 1906 the Northern Pacific expended \$2,548,604 for repairs and renewals of 1,150 locomotives, or \$2,210 per locomotive. The average weight of each locomotive was 78 tons, not including the tender. The accounting records showed that, in round numbers, \$13,000,000 had been paid for these locomotives, or \$11,300 each. Since most of them were purchased when

prices were considerably lower than they are today, we may safely add 10 to 15% to arrive at the present value of this equipment new. Assuming \$13,000 as the cost of each locomotive new, we have annual charge of 17% for repairs and renewals. But, at the actual cost of \$11,300, the repairs and renewals charge amounts to 20%.

The average age of locomotives on the Northern Pacific is 10.7 years, although the average "weighted age" is 8.6 years. In estimating the present value of equipment it is necessary to consider only the average "weighted age." By this expression we mean the age of the dollar invested. To illustrate, suppose there are two locomotives, one costing \$8,000 and 20 years old, and the other costing \$20,000 and 2 years old. The average age of these two locomotives is 11 years, but the average "weighted age" is 7.1 years, ascertained thus:

$$\$8,000 \times 20 \text{ years} = \$160,000 \text{ one year.}$$

$$\$20,000 \times 2 \text{ years} = \$40,000 \text{ one year.}$$

$$\text{Total, } \$28,000 \times ? \text{ years} = \$200,000 \text{ one year.}$$

$$200,000 \div 28,000 = 7.1 \text{ years.}$$

If the annual depreciation is 3.6%, then the total depreciation is $7.1 \times 3.6 = 25.56\%$. Hence the present value of these two locomotives is $100 - 25.56 = 74.44\%$.

Had the actual average age of 11 years been used in the calculation it is obvious that an erroneous present value would have been secured.

Having ascertained that the cost of depreciation and repairs of locomotives averages about 20%, let us compare it with that of steam road rollers, which are somewhat similar machines.

In Gillette's "Handbook of Cost Data," p. 143, records are given showing the cost of maintenance of steam rollers to be about 5 to 6% per annum. At first sight this seems to be widely at variance with the 15% annual repair charge for locomotives, but it is not. These steam road rollers actually worked only 100 days annually due to the short road building season and the limited amount of work required of them. Had they worked 300 days the item of repairs would have been about 3 times as great as it was, or about 15 to 18% per year of 300 days worked.

(For confirmatory data as to repairs of steam rollers and number of days worked, see Engineering Contracting, July 3, 1907, and June 10, 1908.) In order to make comparisons of the cost of maintaining machines, it is essential that both the number of days worked and the amount of work done should be recorded. Then reduction to a year of 300 days, single shift, should be made, as above.

If we assume 15% as a fair annual (300 day) allowance for machines of the general type of locomotives and steam rollers, we have an allowance of 0.05% for repairs per working day. If we assume 21% for annual depreciation and repairs, we have 0.07% per working day for depreciation and repairs. Since the working day is so frequently the unit used in estimating costs

and outputs on contract work, it is well to reduce annual depreciation and repairs to daily depreciation and repairs, as above.

In *Engineering Contracting*, Oct. 23, 1907, some valuable statistics as to the life of equipment on the Union Pacific and Southern Pacific Rys. will be found.

Methods and Cost of Melting Snow in Switches.

BY JAMES S. LANG, M. E., E. E.

No one, with the exception of the railroad man, can realize the excessive expenditure of nerve-racking energy on the part of the railroad employes to insure safe and undelayed traffic.

This is particularly true during the winter months with its snow and sleet storms and its freezing temperature, causing the water from leaky locomotive tanks, overflow from injector pipes on engines, drips from car heating piping, and water from train lavatories and kitchens, emptied into the switch and interlocking mechanism in the railroad yards, to freeze; thereby rendering the switches inoperative.

In answer to the problem, various schemes have been projected whereby it was proposed to free the track and interlocking mechanism of snow and ice, but they all have the great disadvantage of necessitating an extensive and costly installation under and around the rails and switch mechanism. This fact, alone, has rendered them impracticable even if it were not necessary to remove such installations whenever it became necessary to tamp the ties or make other track repairs, and also the fact of the short life of metal fittings in railroad yards, due to the action of the acid from the sparks and cinders. Such installations are also liable to derangement, or even to be put entirely out of commission, at the critical time of a blizzard, in case of a derailment which is more likely to occur at the time of a storm than at any other.

During the past year a great deal of attention has been attracted by the new system of snow melting used at several of the largest terminals in the country. This method of freeing switches from snow and ice bids fair to come into very general use by reason of the great reduction of cost over present methods, and the freedom from delay which it insures.

This method seems to be the only one of the many which have heretofore been proposed, which is thoroughly practical. Its practicability has been demonstrated by its use during the past three winters at one of the busiest terminals in the country, with the result that delays due to snow and sleet storms have been almost entirely eliminated.

One of the most striking features of this method is its extremely low cost, both of installation and operation. The low cost of installation is possible on account of the small amount of apparatus required in

comparison to the number of switches protected. Instead of requiring piping or permanent apparatus for each switch, several switches are handled with no more apparatus than is necessary for one, and nothing that might in any way interfere with either the operation or the repair of switch or track is used.

The cost of operation is also extremely small, and even complicated and busy yards may be taken care of by the regular track and interlocking forces without any extra help whatever. The saving in operation by this method as compared with the usual method of hand cleaning, will pay the entire cost of installation in a single large storm.

The advantage of money saving is, however, of secondary importance as compared with that of the elimination of delays and the derangement of schedules.

Usually it is expected that improvement in service is to be obtained as the result of increased cost or outlay of some sort. In this case, however, it is claimed that the train service may be radically improved, while the cost instead of being increased is reduced to a small fraction of the usual amount.

The melting of the snow or ice is effected by applying to it a flaming fluid of special character, which continues to burn while in the snow, melting and finally evaporating the greater portion of it. On account of the special character of the fluid the flame is easily maintained regardless of the high winds of the storm or the drifting of the snow.

The fluid is applied by the regular track force by means of a safety distributing can, and the height and extent of the flame can be regulated with ease.

No injury to track results from the use of this system, as the temperature of the rails is not raised to the usual summer heat, while the fluid being a hydrocarbon acts as a preservative of the ties.

The light given off by the flame during the hours of darkness, by rendering the forms of the men visible, lessens the danger of personal injury.

Inasmuch as the requirements of locations differ, it is necessary that the installation be specially adapted for the individual location.

One of the first steps in installing this system, is necessarily the installation of sufficient storage capacity for the fluid. This would vary in proportion to the number of switches which it was desired to keep operative, the average severity of the storms and the facilities for obtaining the fluid. The fluid is obtainable in the open market at from three to five cents per gallon and may be obtained free of cost by railroads operating their own Pintsch gas plant.

At one plant, where this system has been in use, the tank, having a capacity of several thousand gallons, was connected with the compressed air used by the interlocking system, and when about ten pounds

air pressure was admitted to the tank, the liquid was forced, through buried piping, to the several drawing outlets, located in various parts of the yard.

The storage arrangements may therefore vary from only a single 200 gallon iron drum, elevated upon blocking, where only a few switches are to be looked after, to a tank of several thousand gallon capacity feeding various lines of underground piping, in yards where the number of switches is large, the territory extensive, or where it is inconvenient or dangerous to cross tracks or where there is no convenient nearby location for tank.

The supply stations for the distributing of the fluid are provided with safety self-closing faucets, and drawing gauges which enables the operator to readily tell, when the cans are being filled, how much fluid they contain, and how much is being used. The storage for the fluid may be by means of a single large tank connected by underground piping to various drawing outlets suitably located with reference to the territory to be protected. It may also be stored and distributed from small iron drums or barrels located upon blocking in various parts of the yard to be served. The latter method of distribution is cheaper in first cost, though not as slightly or convenient as the former.

It may be of interest to give a comparison between this method of switch cleaning, and the ordinary method of hand cleaning, and below is given data derived from a storm occurring during the past winter at one of the busiest of the railway yards. In comparison with the results obtained by the hydrocarbon system is given a careful estimate of corresponding cost of hand cleaning, based upon the experience of previous years, and corresponding snow-fall.

Hand Cleaning Yard Switches.

150 extra men, 24 hours each, 360	
hours, at 20c.....	\$ 720.00
33 regular men (including fore	
man), 30 hours each.....	181.70
Meals: 150 men, 3 meals each,	
150 meals; 33 regular men, 3	
meals each, 99 meals; or a total	
of 519 meals, at 20c.....	109.80
	\$1,011.50

Using Snow Melting System.

No meals (men could leave to eat).	
No extra men.	
Regular men, 20 hours each (dura-	
tion of storm 24 hours, absent	
1 hours for meals).....	\$ 121.80
Hydrocarbon, 1,900 gallons at 4c..	76.00
Incidental charges, and rentals,	
which might regularly be	
charged to storm in question...	66.60
	\$ 264.40

Saving effected in one storm, \$747.10

The severe storm above was taken care of without a single delay chargeable to snow, and switch failures were less than one per cent of usual number.

*From a paper read before the Railway Signal Association, Sept. 8, 1908.

Bridges, Buildings and Foundations

Note: This section is devoted to methods and costs of constructing steel and masonry bridges and buildings and of foundation work of all kinds. It will give special attention to erection plant and tools, falseworks and centers and cost data of all kinds.

Data on 32 Concrete and Reinforced Concrete Bridges (20 Highway and 12 Railway) Including Yardage, Cost, Etc.

An engineer is frequently called upon to estimate the probable cost of a bridge before plans are drawn for the structure. In such cases it is very desirable to have at hand the cost of several similar structures as a guide to the judgment. It is also desirable to have a short description of each structure, and a statement of the quantities of material involved in its construction. With such data at hand an engineer, even though somewhat inexperienced, is not likely to go far wrong in his preliminary estimate of cost—his reconnaissance estimate, if you choose to call it so.

Valuable as such records of cost are for the purpose just indicated, they possess an additional value that should not be underrated—namely: as a guide in comparing the relative economy of the designs of two similar bridges. For this latter purpose it is desirable to have a record not merely of the total yardage of concrete in each bridge, but the distribution of that yardage in the various parts of the bridge. The yardage in the arch ring, the yardage in the spandrel walls, the yardage in the abutments and so on should be given, together with the weight of steel reinforcement in each of these groups of concrete yardage. Unfortunately, however, the published records of concrete bridges are almost invariably lacking in this respect, as will be noted in the following records.

In this connection, a word as to what every record should contain. The following dimensions should be given: The total length of the bridge over all, total length between abutments, length of barrel or true width of bridge, width of floor surface, width of road way or carriage way, width of side walks, clear span of arch and rise, thickness at crown and at spring line, height of abutments and piers up to the spring line, width of piers at spring line, width of abutments at base, height of road way above crown of arch, and ditto above low water.

When these dimensions are given, accompanied by a general description of the type of bridge and a detailed tabulated statement of quantities, the reader can form a very accurate idea of its general design.

In comparing the costs of any two concrete bridges, the first step should be to ascertain the cost per lineal foot measured between abutments. If there are several arches in series, the same holds true. If the

bridges are single or double track railway structures a direct comparison of costs is then possible, but if they are highway bridges, it is necessary to ascertain the cost per square foot of floor area, for highway bridges differ so greatly in width. This floor area should not be estimated for the total length of the bridge over all, but only for the length between the abutments of the extreme spans. The retaining walls of highway bridges are frequently mere extensions of the spandrel walls, and it is deceptive to include all the area between these retaining walls as floor area, although it is frequently done. The fraction of a yard of concrete per sq. ft. should be stated. Where a large main arch is approached on each side by a number of small arches or by a concrete trestle, it is clear that the major part of the cost of the bridge may often be charged to this main arch. Hence it is not good practice to lump both the main arch and the approaches together in estimating the cost per lin. ft. or per sq. ft. of floor. Yet this is almost invariably done, as will be seen from the following records. One cost per lin. ft. or per sq. ft. should be estimated for the main span or spans, and a separate unit cost for the approach spans.

The live loads should be stated as a rule, although if the date of construction is given, together with the type of bridge, an engineer can readily ascertain what was the prevailing practice as to loading at that time. Since nearly all the bridges recorded in this article were built during the last decade, it seems unnecessary to state the loading.

The reader should note the fact that many of the concrete railway bridges have replaced steel bridges and that in nearly every case the steel bridge was approximately 20 years old when replaced. These steel bridges had in all cases become too light for the heavy locomotives and cars. So far as the past is concerned, this indicates a depreciation in steel railway bridges of about 5% per annum in America—a fact which is itself worthy of sober thought on the part of the bridge designer. We may also add in this connection that the average life of an American locomotive is not far from this same 20 years.

We shall first give the records of materials or cost, or both, of 20 highway bridges, as completely as was possible to secure them. It will be noted that for the usual spans of arches and heights of piers, reinforced concrete highway bridges have cost about \$4 per sq. ft. of floor area.

We suggest that it will be wise to scan each of these records, if only for the pur-

pose of impressing upon the mind where they may be found when needed. In subsequent issues we shall give more records of a similar sort, and records of the cost of a large number of steel highway and railway bridges, including most of the monumental bridges in America.

Cost of 25 Ft. Arch for Highway.—A reinforced concrete highway bridge was built in 1902 in Wabash county, Ind. It is an arch with a span of 25 ft., a crown thickness of 8 ins. and a roadway 16 ft. wide. The abutments are tied together by steel rods buried in a concrete pavement below the bed of the stream, according to the Lutén method. The contract price was only \$573, which is equivalent to \$23 per lin. ft., or \$1.44 per sq. ft. of floor. This price bears testimony to the economy of the design.

Cost of 45 Ft. Arch for Highway.—A reinforced concrete highway bridge was built in 1902 over the River Des Peres, Forest Park, St. Louis, Mo. It is a single arch span of 45 ft., with a rise of 12 ft., and a width of 45 ft. out to out. The abutments are 8 ft. high to the spring line. The bridge cost \$12,600 (including \$2,000 for excavation and riprap), which is equivalent to \$280 per lin. ft., or \$6.20 per sq. ft. of floor.

Cost of 54 Ft. Arches for Highway.—A reinforced concrete highway bridge was built in 1903 across the Kalamazoo River at Plainwell, Mich. The bridge is 414 ft. long between abutments, and has an 18 ft. carriage way and one 5 ft. sidewalk. It consists of 7 arches having a span of 54 ft. and a rise of 8 ft. Piers are only 6 ft. high to the spring line, 6 ft. wide at the spring line and rest on piles. The water was only 4 ft. deep. The arches are 1:2:4 concrete and the piers, etc., 1:3:6. The arches are reinforced with 4 in. channel steel. The materials used were:

	Cu. Yds.
Concrete in foundations.....	570
Concrete in arches.....	770
Concrete in walls.....	150

Concrete total.....1,490
Steel, 36,000 lbs.
Earth fill, 1,914 cu. yds.

The contract price was \$19,900, which is equivalent to \$2.10 per sq. ft. of floor. There is less than 0.16 cu. yd. of concrete per sq. ft. of floor.

The detailed cost of this bridge is given in Gillette and Hill's "Concrete Construction—Methods and Cost."

Cost of 60 Ft. Arches for Highway.—A reinforced concrete highway bridge was built in 1906 across the Hudson River at Sandy Hill, N. Y. The bridge is 984 ft. long between abutments and 35 ft. wide. Its deck is 24 ft. above the water surface. The river is shallow and flows over a slate rock bottom. The water is 8 ft. deep only at times of very high water. The bridge consists of 15 arches of 60 ft. span and 8½ ft. rise. The piers are 13 ft. high to the spring line. Each arch span is composed of

7 reinforced concrete arch ribs, and the ribs support a reinforced concrete slab flooring. All concrete was a 1:2:4 mixture, except the hearting of piers and the footing courses, which were 1:3:5. About 11,000 bbls. of cement were used. The outside facing of the piers and parapet walls consisted of concrete blocks. The bridge was built by day labor at a cost of \$80,000, which is but slightly more than \$80 per lin. ft., or \$2.30 per sq. ft. of floor, which is an exceptionally low cost per sq. ft., and indicates excellent design. The bridge was designed and built by Mr. M. O. Kasson of Sandy Hill, N. Y.

Cost of 66 Ft. Arches for Highway.—A reinforced concrete highway bridge was built in 1903 at Bridge St., Jacksonville, Fla., over the tracks of several railways, by the Concrete-Steel Engineering Co., under the Melan and Thatcher patents. The total length is 845 ft., consisting of 11 arches having an average span of about 66 ft. and a rise of 7 ft., with piers about 20 ft. high and 126 piles under each pier. The width of the bridge was 58 ft. between hand rails. The contract price was \$149,900, which is equivalent to \$177 per lin. ft., or \$3 per sq. ft. of floor.

Cost of 80 Ft. and 65 Ft. Arches for Highway.—A reinforced concrete highway bridge of ingenious design was built in 1904 across Clifty Creek, six miles north of Greensburg, Ind., by the National Bridge Co., of Indianapolis, Daniel Luten, president. The bridge is an arch of 80 ft. span and 12 ft. rise, and has a 16 ft. roadway. The abutments are connected by steel tie rods embedded in concrete, which forms a pavement over which the creek flows. The use of these tie rods greatly reduces the mass of concrete required in the abutments. The mean depth of water was 3 ft. There were 4,500 lbs. of steel used in the ties connecting the abutments, and 4,800 lbs. in the arch and spandrel walls. The concrete amounted to only 265 cu. yds. and the contract price for this bridge complete was only \$2,695, which, so far as we know, breaks all records for low cost of a single concrete arch bridge of 80 ft. span. The cost was therefore only \$34 per lin. ft., or \$2.10 per sq. ft. of floor, or \$10 per cu. yd. There is only 0.26 cu. yd. per sq. ft. of floor. This design of Luten arch is illustrated on page 785 of Reed's "Concrete and Reinforced Concrete Construction."

Another highway bridge of the same type is the East Washington St. bridge at Indianapolis. It has a span of 65 ft., a rise of 10 ft. and a roadway 57 ft. wide. It contains 1,100 cu. yds. concrete and the contract price was \$10,885, which is equivalent to \$167 per lin. ft., or less than \$3 per sq. ft. of floor, or \$10 per cu. yd. There is 0.3 cu. yd. of concrete per sq. ft. of floor.

Cost of 75 to 100 Ft. Arches for Highway.—A reinforced concrete highway bridge was built in 1905 across the Wabash River at Peru, Ind. Its length is 700 ft., and the roadway is 30 ft. wide. The height of roadway is 30 ft. above low water. The

bridge consists of 7 arch spans; one 100, two 95, two 85 and two 75 ft. The rise of the arches is 13 to 15 ft. The piers average 30 ft. high and rest on solid rock 6 to 16 ft. below low water. The bridge contains 5,000 cu. yds. of concrete, which required 6,000 bbls. of cement. The concrete was reinforced according to the Luten system. The contract price was \$36,900, which is equivalent to only \$53 per lin. ft., or \$1.80 per sq. ft. of floor, or \$7.20 per cu. yd. There is 0.21 cu. yd. of concrete per sq. ft.

This is a remarkably low cost and is indicative of good design. This contract price was lower than competitive bids for a steel bridge of the same length having wooden flooring. This bridge was designed by the National Bridge Co. of Indianapolis, Ind., Daniel Luten president.

Cost of 80 Ft. Arch for Highway.—A concrete highway bridge was built in 1901 across San Leandro Creek, near Oakland, Cal. It is an arch (not reinforced) having a span of 81 ft., a rise of 26 ft., a crown thickness of 3 ft. and supports a macadam carriage way 41 ft. wide with 8 ft. sidewalks on each side, giving a roadway 57 ft. wide. The abutments have a thickness of 30 ft. and extend only 5 ft. below the spring line, and rest on clay. There were 90,000 ft. B. M. used in the centers and forms, or 24 ft. B. M. per cu. yd. of concrete. The spandrel walls have a length of 192 ft. each. There are 3,384 cu. yds. of concrete in the bridge, and the contract price for its construction was \$25,840, which is equivalent to \$319 per lin. ft. of span, or \$5.60 per sq. ft. of floor. There are 0.74 cu. yds. of concrete per sq. ft. of floor. The concrete was a 1:2:7 mixture, and it will be seen that the contract price for the bridge was equivalent to about \$7.70 per cu. yd. of concrete.

Cost of 85 Ft. Arch for Highway.—A reinforced concrete highway bridge was built in 1903 at Seeley St., over Prospect Ave., Brooklyn. The arch has a span of 85 ft. and a rise of 8½ ft. The carriage way is 32 ft. wide and the sidewalks are each 12½ ft. wide, making a total width of roadway of 57 ft. The total length of each parapet wall is 144 ft. The abutments are 15 ft. high to the spring line. The bridge contains 1,300 cu. yds. of concrete, and 91,400 lbs. of corrugated reinforcing bars. The contract price was \$21,800, which is equivalent to \$256 per lin. ft., or \$4.53 per sq. ft. of floor, or nearly \$17 per cu. yd. There is 0.27 cu. yd. of concrete per sq. ft. of floor.

Cost of 69 to 88 Ft. Arches for Highway.—A reinforced concrete highway bridge was built in 1903 across the Great Miami River on Main St., Dayton, Ohio. Its length is 588 ft. between abutments, and it has a carriageway 40 ft. wide and two 7 ft. sidewalks, making a total width of 54 ft. It consists of 7 arches having spans of 69 to 88 ft., reinforced according to the Melan system. The rise of the arches is 1-10 to 1-13 of the span. The piers are 31 ft. high to the spring line, and the base of piers is

about 15 ft. below low water. The contract price was \$123,170, which is equivalent to \$210 per lin. ft., or slightly less than \$4 per sq. ft. of floor.

Cost of 80 to 110 Ft. Arches for Highway.—A reinforced concrete highway bridge was built in 1904 across the Great Miami River at Third St., Dayton, Ohio. The bridge consists of 7 arches and has a total length of 710 ft. between abutments, and its width is 62 ft. between balustrades. It is of the Melan type, designed by the Concrete-Steel Engineering Co., which received a royalty of \$12,000 paid out of the contract price. The arch spans ranged from 80 ft. to 110 ft., with ratio of span to rise averaging about 7½ to 1. The piers were 22 ft. high. The contract price was \$179,600, which is equivalent to \$253 per lin. ft., or about \$4 per sq. ft. of floor.

Cost of 100 Ft. Arch for Highway.—A reinforced concrete highway bridge was built in 1907, in Rock Creek Park, Washington, D. C., on Ross Drive across Rock Creek. The length is 163 ft. and its width is 16 ft. It consists of a main span of 100 ft. having a 15 ft. rise, with concrete trestle approaches 30 ft. long on each side. The three hinged arch span consists of three ribs carrying, at intervals of 10 ft., light spandrel columns supporting the reinforced concrete beams and floor slabs. A steel handrail is provided on each side. An existing timber trestle was utilized for centering. The bridge was designed for a live load of 100 lbs. per sq. ft., with a concentrated load of only 6 tons on a four wheel wagon. The bridge was built by day labor and cost \$8,000, or \$50 per lin. ft., or \$3.20 per sq. ft. of floor, including approaches.

Materials in 50 Ft. and 100 Ft. Arches for Highway.—A concrete highway bridge was built in 1903 over a mill pond on the Anthony Kill, near Mechanicsville, N. Y. Its length is 265 ft. between abutments, and its width is 17 ft. over all. It consists of two 100 ft. arches and one 50 ft. arch not reinforced. The rise of the 100 ft. arches is about 20 ft. The piers have a height of about 15 ft. Piles were driven to support the centers. There were 140,000 ft. B. M. in the centers and forms, which lumber was used but once. About 2,500 cu. yds. of concrete were required, or 0.56 cu. yd. per sq. ft. of floor. Therefore it took 56 ft. B. M. per cu. yd. of concrete. The centers consisted of bents supporting lagging laid parallel with the center line of the roadway.

Cost of 125 Ft. Arch for Highway.—A concrete highway bridge was built in 1906 at 16th St., Washington, D. C., known as the Piney Creek bridge. Its length is 272 ft. and its width is 25 ft. It consists of a parabolic arch having a span of 25 ft. and a rise of 39 ft., resting on abutments about 12 ft. high, and a concrete viaduct approach on each side of the arch. The arch is not reinforced and is 5 ft. thick at the crown. It carries a solid spandrel wall on each side and reinforced concrete posts between the walls, which support the reinforced concrete slab roadway. The viaduct approaches

are merely extensions of this spandrel construction, and have an average height of about 65 ft.

The design of this bridge is illustrated and described in Reed's "Concrete and Reinforced Concrete Construction." The cost of the bridge was \$52,231, of which \$3,000 was for engineering and \$1,500 for inspection. This is equivalent to a cost of \$200 per lin. ft., or \$8 per sq. ft. of floor area.

Cost of 135 Ft. Arch for Highway.—A reinforced concrete highway bridge was built in 1907 across Cherry Creek, at Bannock St., Denver, Colo. The bridge is a one arch span of 135 ft., consisting of 8 parabolic three hinged arch ribs. This design was adopted because the bridge crosses the creek on a skew of 36°. The rise of the arch is 13 ft., and the arch is 24 ins. thick at the crown. The arch supports a reinforced concrete slab floorway resting on reinforced concrete spandrel posts. The carriage way is 36 ft. wide, flanked by an 8 ft. sidewalk on each side, giving a total width of 52 ft. of roadway. The bridge contains 1,146 cu. yds. of 1:2:5 concrete, 166,000 lbs. of steel reinforcement and 33,000 lbs. of steel castings. There is less than 0.28 cu. yd. per sq. ft. of floor. The contract price was \$28,325, or \$210 per lin. ft., or \$4 per sq. ft. of floor space, or \$24.60 per cu. yd. of concrete. This low cost per square foot for so long a span indicates excellent design on the part of Mr. Charles W. Comstock, M. Am. Soc. C. E. Contrast this design and cost with the design and cost of the Pincey Creek bridge above given.

Cost of 150 Ft. Arches for Highway.—A concrete highway bridge was finished in 1907 over Rock Creek, Washington, D. C., and is known as the Connecticut Ave. bridge. It has a total length of 1,068 ft. between abutments. The abutments are U shape and are filled with earth, giving a total length of 1,341 ft. of bridge including abutments. The bridge consists of five concrete arches (not reinforced), each of 150 ft. span and 75 ft. rise., and two 82 ft. arches of 41 ft. rise. The 150 ft. arches support spandrel arches that carry the roadway. The roadway is about 150 ft. above the base of foundation of the center pier. The bridge is 52 ft. wide. It contains 89,000 cu. yds. of concrete, or 1.62 cu. yds. per sq. ft. of floor. The cost was \$850,000, or \$639 per lin. ft. of total length, which is equivalent to \$12.30 per sq. ft. of floor. Full detailed costs of the materials and labor required to build this bridge are given in Gillette and Hill's "Concrete Construction—Methods and Cost."

Cost of 233 Ft. and 53 Ft. Arches for Highway.—A concrete highway bridge was built in 1906 across the Wissahickon Creek, Philadelphia, and is known as the Walnut Lane bridge. The bridge is 585 ft. long and 60 ft. wide, having a 10 ft. roadway and two 10 ft. sidewalks. It consists of a main arch of 233 ft. span, approached on one side by three 53 ft. arches and on the other side by two 53 ft. arches. The main arch has a rise of 70 ft. and supports 8

spandrel arches. The abutments for this main arch have a height of 15 ft. and rest on rock. The concrete is not reinforced. The main arch consists of twin arch rings, side by side. The contract price for this bridge was \$253,551, which is equivalent to \$431 per lin. ft., or \$7.25 per sq. ft.

Estimated Cost of 703 Ft. Arch for Highway.—Plans for a reinforced concrete highway bridge of unprecedented size have been prepared for the city of New York, and the estimated cost and amount of materials are worthy of record here. The bridge is to be known as the Hudson Memorial Bridge, and is to cross Spuyten Dreyvil Creek. The bridge is to be 2,840 ft. long and 80 ft. wide. The main arch is 703 ft. span and 170 ft. rise, 70 ft. wide, 15 ft. thick at the crown and 28 ft. thick at the spring, and supports 10 spandrel arches. The approaches consist of 3 arches of 100 ft. span on one side and 1 on the other side. The bridge is to carry two decks, one for highway traffic and the other for rapid transit railway traffic. The steel in the arch ring is to be used in compression and is, strictly speaking, not a reinforcement. It averages about 1 3/4% of the volume of the arch ring. There are to be 17,000,000 lbs. of steel in the 47,000 cu. yds. of concrete in the arch ring. The total amount of concrete is to be 75,000 cu. yds. in the main arch, including the spandrels, foundations, etc., which will contain 24,000,000 lbs. of steel. The estimated cost of the arch and approaches (2,840 ft. long) is \$3,800,000, which is equivalent to nearly \$1,310 per lin. ft., or nearly \$17 per sq. ft.

Cost of a Stone Arch Highway Bridge.—A stone highway bridge was built in 1904 across the Connecticut River at Hartford. It is 1,185 ft. long and 80 ft. wide between parapets. It consists of 8 stone arches, having spans of 68 to 119 ft., and a 100 ft. Scherzer rolling lift bridge. The foundations for the piers were put down with pneumatic caissons. The toe of each caisson averaged about 30 ft. below low water level and 50 ft. below the spring of the arch. The piers and parapets are faced with granite, and the backing is concrete. There were 23,300 cu. yds. of concrete in caisson piers, 32,000 cu. yds. concrete backing, 9,300 cu. yds. granite ashlar, 10,000 cu. yds. granite vaussairs, 9,500 cu. yds. arch ring concrete and 300 cu. yds. granite parapet and posts, or a total of 84,400 cu. yds. masonry. There were 20,000 cu. yds. excavation for abutments and 37,800 cu. yds. dredging and excavation for piers. The contract price for the masonry and foundations was \$1,369,520 and the total was \$1,600,000, or \$1,330 per lin. ft., or \$17 per sq. ft. of floor.

Cost of Longest Stone Arch Bridge.—The longest stone arch bridge span in the world was begun in 1903 at Plauen, Saxony. It is a highway bridge with a roadway 36 ft. wide flanked by two sidewalks 10 ft. wide each, making a total width of 56 ft. The arch has a span of 295 ft. and a rise of 59 ft., and a crown thickness of 4.9 ft.

It springs directly from ledge rock. The bridge has a total length of 192 ft. and is built throughout of stone masonry. There are about 15,000 cu. yds. of masonry in the bridge, and 818,000 ft. B. M. of timber were required for the centers and falsework. The centers rested on concrete footings. The cost of the bridge was only \$120,000, due to the low cost of labor in Saxony. This is equivalent to \$8 per cu. yd. of masonry. Hence the bridge cost \$241 per lin. ft., or \$1.35 per sq. ft. of roadway.

Estimated Cost of 50, 75 and 100 Ft. Electric Ry. Arches.—In estimating the cost of double track reinforced concrete bridges for interurban electric lines, Mr. George P. Carver gives the following quantities for 50, 75 and 100 ft. single span arches having a width of 28 ft. These arch spans were all designed to cross streets (not rivers) and had hollow reinforced concrete abutments.

Span.	Concrete.	Steel.	
Ft.	Cu. Yds.	Lbs.	Cost.
50	370	27,700	\$ 1,780
75	740	38,800	8,830
100	1,008	55,650	12,150

It will be noted that the estimated cost is \$12 to \$13 per cu. yd. of concrete, not including the cost of excavation. Prices assumed in making the estimates were as follows:

Steel, 2 1/2 cts. per lb.
Placing steel, 1 ct. per lb.
Cement, \$2 per bbl.
Stone, \$2 per cu. yd.
Sand, \$1 per cu. yd.
Forms, \$1 per cu. yd.
Mixing and placing, \$1.50 per cu. yd.
Add for incidentals 15%.
Add for profit 10%.

Materials in Concrete Railway "Trestle."—A double track reinforced concrete bridge was built in 1900 across Ames Creek for the Illinois Central Ry. It is 72 ft. long between abutments, and is 36 ft. wide out to out. It consists of 4 spans of 15 ft. each, which are such flat arch spans that they are really girders. Fourteen steel I beams (9 in.) are embedded in these spans for reinforcement. The concrete is 18 ins. thick at the crown. The piers are 3 ft. thick at the top and 10 ft. high, resting on piles. The bridge contains 725 cu. yds. of concrete, or 10 cu. yds. per lin. ft.

Materials in Concrete Railway "Trestle."—A double track concrete trestle was built in 1906 across Cave Hollow Creek for the C., B. & Q. Ry. The total length is 80 ft. between abutments. It consists of five spans of 11 ft. each resting on piers 2 ft. wide on top, 30 ft. long and 16 ft. high. The footing of each pier is 5 ft. wide and rests on 26 piles 16 ft. long. The abutments are 12 ft. high. The superstructure is composed of reinforced concrete slabs 16 ft. long, 28 ft. wide and 2 ft. 4 ins. thick, with a parapet 1 ft. high on each side. There are 31,000 lbs. of Johnson corrugated bars and 520 cu. yds. of concrete in this trestle, or 6.5 cu. yds. per lin. ft. A 1:2:1 con-

crete was used in the superstructure and a 1:3:6 in the piers and abutments.

Cost of Concrete Ry. "Trestle."—A single track concrete trestle was built in 1905 for the Illinois Central Ry. at New Athens, Ill. Its length is 82 ft. between abutments and its width is 15 ft. over all or 12 ft. between parapet walls. It consists of 5 arch reinforced spans of 14 ft. each resting on solid piers 3 ft. thick and 19 ft. high. The arches are elliptical, having a rise of 4 ft. and a crown thickness of 16 ins. The footing of the piers is spread at the base to 8x19 ft., giving a load on the earth of $1\frac{1}{2}$ tons per sq. ft. The extrados of the arches is very flat and is at subgrade at the crown, so that the parapet wall, which is 18 ins. thick, has a height of only 18 ins. above the crown. A 1:2:5 concrete was used. The cost was about \$7,500, which is equivalent to \$91 per lin. ft., including a large amount of excavation for piers and abutments.

Cost of 38 Ft. Arch for Railway.—A three track reinforced concrete bridge was built in 1905 across Trim Creek, near Chicago, for the Chicago & Eastern Illinois Ry. The bridge is a reinforced concrete arch span of 38 ft. having a rise of 7 ft. and a width of 48 ft. The abutments are 15 ft. high to the spring. The arch is 26 ins. thick at the crown. The bridge contains 1,578 cu. yds. of concrete and 36,000 lbs. of Johnson corrugated bars. A similar bridge built for the same road cost \$7.60 per cu. yd., including the reinforcing bars, at which rate this bridge would cost about \$12,000, or \$315 per lin. ft., or \$6.55 per sq. ft. There is 0.86 cu. yd. per sq. ft.

Cost of 64 Ft. Arches for Railway.—A double track stone and concrete bridge was built in 1903 across Rock River, at Watertown, Wis., for the C., M. & St. P. Ry., replacing a single track iron bridge built 19 years previously. It is 280 ft. long between abutments and 30 ft. wide over all. It consists of 4 stone arch spans of 64 ft. each, with a rise of $16\frac{1}{2}$ ft. and a crown thickness of 3 ft. The piers are 8 ft. wide at the spring line and 15 ft. high to the spring line, and rest on piles. The parapet walls are each 360 ft. long. The bridge contains 4,000 cu. yds. of stone and concrete masonry, and its cost was \$40,700, including removal of the old bridge, building a temporary bridge, filling and new track. This is equivalent to \$145 per lin. ft., or \$4.80 per sq. ft., or \$10.20 per cu. yd. There is 0.48 cu. yd. per sq. ft.

Cost of 68 Ft. and 82 Ft. Arches for Railway.—A double track reinforced concrete railway bridge was built in 1906 across the Sangamon River, near Decatur, Ill., for the Wabash Ry. Its length is 386 ft. between abutments and its width is 25 ft. between parapet walls. The bridge consists of 4 skew arches (45° skew), two of which have a clear span of 58 ft., measured perpendicular to the piers, or a span of 82 ft. measured along the center line of the railway. The other two arches each have a clear span of 48 ft. measured perpendicular to the piers, or 68 ft. along the center line.

The rise of the arches is 30 ft. and the piers have a height of 35 ft. The three piers are in water about 5 ft. deep. At each end of the bridge is an abutment with side retaining walls 125 ft. long. This bridge was reinforced with corrugated bars. It replaced a steel bridge built 21 years previously. The following quantities were involved in the construction:

Earth excavation, cu. yds.....	8,320
Piling, lin. ft.....	36,775
Foundation slabs for piers, concrete, cu. yds.	1,300
Piers proper, with skewbacks, concrete, cu. yds.....	2,270
Arch rings, concrete, cu. yds.....	2,370
Spandrel walls of arches, concrete cu. yds.....	2,180
Foundations for abutments, concrete, cu. yds.....	1,580
Abutments above foundations, including slabs and intermediate walls, together with spandrel walls, concrete, cu. yds.....	5,930
Retaining walls, concrete, cu. yds....	510
Reinforcing bars, lbs.....	430,000

The cost was \$124,000, which is equivalent to \$321 per lin. ft., or \$12.80 per sq. ft. of roadway. The total amount of concrete is 16,170 cu. yds., so that the cost of the bridge was equivalent to \$7.65 per cu. yd. There are 1.68 cu. yds. per sq. ft.

Materials in 74 Ft. Arch for Railway.—A four track concrete bridge, 160 ft. long, was built in 1904 across the Ashtabula River, Ohio, for the Lake Shore Ry. It comprised two 74 ft. concrete arches having a rise of 37 ft., resting on piers and abutments only 6 ft. high. The arches were 7 ft. thick at the crown and 21 ft. at the spring, and were not reinforced. An earth fill 30 ft. deep over the crown was placed upon the arches, making it necessary to have the barrels of the arches 145 ft. long. There were 17,500 cu. yds. of concrete and 50,000 cu. yds. of earth fill. This bridge is a good example of poor design, for, at \$8 per cu. yd. for concrete and 15 cts. per cu. yd. for fill, its cost would be \$147,500, or more than \$900 per lin. ft., or about \$18 per sq. ft. of roadway. A narrow bridge with spandrel piers supporting the roadway could have been built at far less cost. It will be noted that there were about 2.2 cu. yds. of concrete in this bridge per sq. ft. of roadway.

Materials in 75 Ft. Arch for Railway.—A reinforced concrete railway bridge was built in 1903 over Big Rock Creek, 51 miles west of Chicago, on the line of the C., B. & Q., replacing a steel bridge built 22 years previously. The span is 75 ft. The bench walls are 12 ft. high, and the rise of the arch is 28 ft. It is a three center arch 3 ft. thick at the crown and the barrel length is 41 ft. There is no appreciable fill over the crown. The arch is designed for a loading of 1,000 lbs. per sq. ft. The wing walls are each 55 ft. long, and $10\frac{1}{2}$ ft. thick at the bottom. The abutments of the arch are 25 ft. wide at the base. Abutments and wing walls rest on piles. Corrugated steel bars are used for reinforcement. There

are 6,588 ft. of $\frac{3}{4}$ in. bars and 21,046 ft. of $\frac{7}{8}$ in. bars in the bridge. The arch ring is 1:2:4 concrete and contains 770 cu. yds. The rest of the concrete is 1:3:6. The total concrete in the structure is 3,350 cu. yds., or nearly 45 cu. yds. per lin. ft., or 1 cu. yd. per sq. ft.

Materials in 80 Ft. and 100 Ft. Arches for Railway.—A double track concrete bridge was built in 1906 across the Vermillion River, for the Cleveland, Cincinnati, Chicago & St. Louis Ry. It consists of two 80 ft. arches and one 100 ft. arch between them. The piers of the 10 ft. arch are 30 ft. high to the spring line, and the arch has a rise of 40 ft. These main arches support a series of small spandrel arches having spans of 8 ft., resting on piers 2 ft. thick. The crown thickness of the 100 ft. arch is 4 ft. The base of rail is 20 ft. above the crown and 90 ft. above the foundation of the center piers. The bridge has a total length of 290 ft. between abutments, a width of 29 ft. between parapets, and contains 12,000 cu. yds. concrete, or nearly 41 cu. yds. per lin. ft., or 1.41 cu. yds. per sq. ft. The bridge is designed as a plain concrete bridge, although steel reinforcement is used as a precautionary measure. There were 260,000 lbs. of Johnson corrugated bars used. The bridge required 500,000 ft. B. M. for centers and forms, which is equivalent to 42 ft. B. M. per cu. yd.

Materials in 100 Ft. Arches for Railway.—A single track concrete bridge was built in 1906 across the Cumberland River for the Kentucky & Tennessee Ry. It is 500 ft. long between abutments, consisting of 5 spans of 100 ft. c. to c. of piers, and the width is 16 ft. between parapet walls. The bridge is on a 30° skew. The arches have a rise of 18 ft. and a crown thickness of 3 ft. 7 ins. The piers are 40 ft. high. There are 6,470 cu. yds. of concrete and 210,000 lbs. of twisted steel reinforcement in this bridge. This is equivalent to nearly 13 cu. yds. per lin. ft. of bridge, or about 0.8 cu. yd. per sq. ft. of roadway.

Cost of 140 Ft. Arches for Railway.—A double track concrete railway bridge was built in 1902 across the Big Muddy River for the Illinois Central Ry., to take the place of a single track steel bridge built 13 years previously, which was getting too light for the traffic. The bridge is 463 ft. long between abutments and 32 ft. wide, or 26 ft. between parapet walls. It consists of three elliptical arches (not reinforced), each having a span of 140 ft., a rise of 30 ft. and a crown thickness of 7 ft. These main arches supported spandrel arches of 13 ft span reinforced with steel skeletons made principally of rails. The piers are about 22 ft. high to the spring line and are built around and over the old single track bridge piers.

The total cost was \$125,000, which is equivalent to \$270 per lin. ft., or \$10 per sq. ft. of roadway. There were 12,000 cu. yds. of concrete, or 26 cu. yds. per lin. ft., or 1 cu. yd. per sq. ft. of roadway; 5,000 cu. yds. of excavation, which cost 76 cts. per cu.

yd.; 400,000 ft. B. M. in cofferdams, centers and forms, and 300,000 lbs. steel reinforcement. The labor cost of handling, punching and erecting the steel was 0.61 ct. per lb.

Materials in 140 Ft. Stone Arch for Railway.—A double track stone bridge was built in 1899 across the Connecticut River, at Bellows Falls, Vt., for the Fitchburg railroad. It consists of two stone arch spans of 140 ft. each, having a rise of 20 ft. The width over all is 27 ft. The arch sheeting is 4 ft. thick. The bridge is peculiar in that it has no masonry abutments or pier, the arches springing directly from ledge rock on each bank and from a rock island in the center of the stream. This natural pier in the middle of the river is 32 ft. thick along the spring line, thus giving a total length of bridge of 312 ft. between the natural abutments. There were 232,000 ft. B. M. required for the centers, or 55 ft. B. M. per cu. yd. of masonry in the bridge. The masonry was as follows:

	cu. yds.
Ring stones and skewbacks.....	1,262
Coping	286
Rubble	2,467
Concrete in foundations.....	180
Total	4,195
This is equivalent to 13½ cu. yds. per lin. ft.	

The Panama Railroad Company is making experiments with canary yellow, Pullman green, and maroon to find out which paint is the most serviceable in the climate of the Isthmus. The maroon is the color now in use. One passenger coach has been painted green and another yellow, and they are running every day in one of the passenger trains, alternating in position next to the engine. At present the yellow is giving best service.

A contract has been entered into between the Republic of Cuba and the McGivney & Rokeby Construction Co., 1 Broadway, New York, whereby the McGivney & Rokeby Construction Co. agreed with the Republic of Cuba to carry out the original contract made between the City of Havana and Ralph T. Rokeby and Samuel P. McGivney on Jan. 10, 1902, for the paving and sewerage of the city. The paving portion of the work will be done by the Uvalde Asphalt Paving Co., 1 Broadway, New York, and the Cuban Engineering & Contracting Co., 32 East 23d St., New York, a recently organized corporation, of which D. L. Hough is Managing Director, will carry out the sewer work. It is reported that the cost of the work will amount to about \$16,000,000.

The total estimated cost of the track elevation work in Chicago, Ill., completed to Dec. 31, 1907, was \$16,520,250. The total number of miles of main track elevated was 122.83; total number of miles of all track elevated was 681.29.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Production of Brick and Average Price in United States in 1907.

The following data on the production of common brick, vitrified paving brick and front brick are taken from a table of statistics on the clay products of the United States for 1907, recently issued by the U. S. Geological Survey. A similar table showing the price of brick in 1906 was published in our issue of Sept. 18, 1907.

State.	Common Brick.		Vitrified Paving Brick or Block.		Front Brick	
	Quantity. (Thou.-sands.)	Average price per thousand.	Quantity. (Thou.-sands.)	Average price per thousand.	Quantity. (Thou.-sands.)	Average price per thousand.
Alabama	159,315	\$6.31	13,362	\$13.76	*	\$13.90
Arizona	10,988	9.11	..	..	*	13.73
Arkansas	68,463	6.85	..	10.00	1,010	11.82
California	339,439	7.32	*	15.79	12,922	21.93
Colorado	118,551	6.78	3,145	12.01	24,572	10.36
Conn. and Rhode Island	198,414	6.25	*	24.23	*	15.44
Delaware	22,047	7.96	..	..	*	19.40
Dis.riet of Columbia..	28,735	7.63	..	..	..	..
Florida	51,779	6.64	..	..	*	15.00
Georgia	318,844	5.67	*	12.50	1,625	10.12
Idaho and Nevada....	34,034	8.80	*	25.14	361	21.26
Illinois	1,494,807	4.35	126,927	11.08	20,828	12.78
Indiana	251,766	6.00	16,224	11.87	36,890	11.87
Iowa	157,618	6.89	21,686	10.29	8,028	12.00
Kansas	263,887	4.51	85,110	8.55	24,381	9.72
Kentucky	143,731	6.49	*	14.27	7,926	10.92
Louisiana	110,386	7.60	..	..	*	11.50
Maine	54,815	7.19	*	15.00	*	10.00
Maryland	166,768	6.16	*	15.00	1,597	12.43
Massachusetts	184,005	7.04	..	..	*	37.13
Michigan	200,817	5.88	7,911	11.96	3,956	8.12
Minnesota	168,931	6.19	*	12.00	*	12.93
Mississippi	114,054	6.87	..	..	1,608	12.92
Missouri	264,462	6.97	47,807	9.67	30,178	12.84
Montana	21,957	8.60	*	15.01	*	20.00
Nebraska	117,276	6.73	2,900	8.48	7,280	13.83
New Hampshire.....	66,737	7.50	..	..	..	..
New Jersey	388,735	5.89	*	13.31	61,521	13.42
New Mexico.....	15,275	7.63	*	10.00	4,047	12.69
New York.....	1,319,416	5.35	18,516	13.70	12,265	16.17
North Carolina.....	174,800	6.58	*	10.00	770	10.29
North Dakota.....	27,058	7.77	..	..	4,067	16.59
Ohio	495,025	6.09	264,571	10.10	88,992	11.61
Oklahoma	88,124	6.70	4,528	8.76	1,752	11.98
Oregon	42,857	8.30	*	20.00	1,713	29.13
Pennsylvania	980,102	6.48	115,729	10.65	134,869	11.32
South Carolina.....	125,642	6.05	..	..	1,850	14.46
South Dakota.....	4,072	9.85	..	..	..	..
Tennessee	170,972	6.06	*	11.98	15,514	10.93
Texas	243,853	7.00	*	10.36	11,494	13.33
Utah	50,982	7.00	..	..	14,166	11.83
Vermont	12,724	6.54	..	..	*	10.00
Virginia	197,052	6.52	..	..	19,989	14.53
Washington	101,905	8.31	*	18.22	4,539	28.03
West Virginia.....	58,102	6.61	60,681	15.69	*	15.16
Wisconsin	158,602	6.43	*	8.04	4,106	10.57
Wyoming	7,774	10.04	..	..	728	14.18
Other States.....	..	..	57,148	13.91	20,399	14.73
United States.....	9,795,698	6.00	876,245	11.02	585,943	12.51
Total, 1906.....	10,027,039	6.11	751,974	10.45	617,469	12.79

*Included in "Other States."

†Includes all products made by less than three producers in one state

Two steers came to an untimely end recently at Bremen, Ind., through their careless handling of high explosives. According to a veracious press report: "The cattle were grazing in a field where a farmer was blasting stumps. During his absence the steers ate a quantity of dynamite. When driving them home the farmer threw a stone at the herd. The missile struck one of the steers that had eaten the

dynamite and the shock exploded the stuff in the animals stomach and the steer was blown to atoms." The shock detonated the other steer and some more atoms were made.

On June 30, 1907, the total single track railway mileage in the United States was 229,951.19 miles, according to statistics of the Interstate Commerce Commission

Methods and Cost; Some Old, Some New.

Breaking Up Concrete Foundation.—

A method which has been successfully employed in breaking up old concrete foundation for street railway track consists in mounting pile driver leads on a revolving frame carried by a single truck platform car and battering the concrete to pieces with succession blows of a 500-lb. hammer fitted with a heavy chisel blade. The leads swing around a complete circle 18 ft. in diameter and the hammer is operated by an electric hoist on the car. When the apparatus has to be moved the leads are tipped back to lie flat on the car. It is stated that the machine will break as much concrete in a day as a gang of 20 men.

Price of Cast Iron for Past 13 Years.—

The average cost of cast iron pipe per ton since 1894 to the Water Pipe Extension Division of the City of Chicago, Ill., has been as follows:

	Cost Per Ton.	Per cent. Variation in Cost.
1895	\$26.00	100
1896	23.00	88.4
1897	19.00	73.0
1898	25.00	96.1
1899	25.50	98.0
1900	25.50	98.0
1901	23.50	90.4
1902	28.00	107.7
1903	33.00	126.9
1904	30.00	115.4
1905	27.50	105.8
1906	30.00	115.4
1907	37.20	143.1

Disposal of Spoil by Sluicing.—Excavation for the new foundations for the Lake View pumping station at Chicago, Ill., was done by means of common horse scrapers for a depth of 6 ft. From that point a traveling derrick operating a $\frac{3}{4}$ yd. orange peel bucket was used. For disposing of the excavated material, the contractor erected a wooden hopper 8 ft. square, supported by frame work, some 20 ft. above the ground, into which the orange peel discharged its load. From the hopper a line of wooden troughs lead to the shore of the lake and the excavated material (a mixture of sand, gravel and round stones as large as 3 in. in diameter) was washed through the trough. One stream was directed into the hopper and two into the trough near the hopper. After removal of dirt by sluicing had been in operation about a month, the contractors began the use of wire screens laid horizontally in the troughs separating the gravel, large round stones and torpedo sand from the excavated material. A large quantity of gravel and two grades of torpedo sand were obtained, most of which was used in the concrete work.

Cost of Digging a Drainage Ditch with a Dredge.—These costs were obtained from records of actual work done and from the regular expense accounts. The dredge was a Bucyrus with $1\frac{1}{2}$ cu yard dipper, 40 ft. dipper handle, 65-ft. boom, 10x12-in. double cylinder hoisting engine, 7x9-in. double cylinder swinging engine and 80 HP. boiler. The ditch was in heavy black soil, 30 ft. wide on the bottom and 8 ft. deep with sides sloped 1 on 1. The machine excavated 1,140 cu. yds. per 10-hour day at the following costs for operation:

1 engineer	\$5.00
1 craneman	3.00
1 fireman	2.50
2 roustebanks at \$1.75	3.50
2 $\frac{3}{4}$ tons of coal	8.50

Total per 10-hour day.....\$22.50

Total per cu. yd. excavated \$1.95.

Repairs, depreciation and interest on plant are not included.

Cutting Weeds on Interurban Ry. Right of Way.

The accompanying illustration shows a method employed by the Rockford & Interurban Ry. Co., of Rockford, Ill., for mowing the weeds on its right of way. The mower is an 8 ft. standard Emerson machine with extra long shaft. Interurban car wheels have been substituted for the usual wheels on the mower, it being found that the former were sufficiently heavy to form the necessary traction to run the mower. The mower cuts a swath of 8 ft. from the rail at the rate of about five miles an hour. Of course, it is not possible to maintain this rate of speed as all passenger and express trains have to have right of way. The company has mowed about 80 miles of right of way on each side of the track and did not have any trouble in any way. The mowing was

was used on the mower to raise the bar to an upright position whenever the machine came to a pole, which necessitated losing some time but nothing serious. For a motor car a city car was used, adding enough resistance to enable the car to be run at a low rate of speed without heating the same. The arrangement was devised by Mr. Edwin Main, Chief Engineer of the railway.

Prices Paid for Track Materials.—In an address before the California State Board of Equalization Mr. Thos. Mellersh, Comptroller Northwestern Pacific R. R., gave the following figures as showing the cost of materials to the Atchison, Topeka & Santa Fe R. R., in 1897 and 1907:

	In- crease	1897.	1907	per- cent.
Sawn ties		\$0.18	\$0.39	116.5
Hewn ties		.19	.35	84.2
Lumber, lowest grades		10.50	17.50	70.0
Lumber, highest grades		17.75	23.90	36.8
Rails		18.00	30.36	68.6
Spikes		1.27	2.00	56.1
Track bolts		2.20	2.80	27.3
Tie plates		.04	12375	173.4
61-lb. angle splices ..		25	29	18.0
Rock, ballast		.50	.60	20.0
Bar iron		1.20	1.70	41.6
Sheet steel		1.50	1.76	17.7
Cast iron		1.55	1.46	58.7
Wheels, 600 lbs.		6.00	7.00	16.6
Stock brass		12.00	28.00	133.3
Nails		1.45	2.00	37.9
Coal		1.14	1.65	44.7

The first regular meeting of the Western Society of Engineers for the fall session is to be held Sept. 2. Mr. H. von Schon, of Detroit, Mich., will present a paper—



View Showing Mowing Machine Cutting Weeds.

done through very heavy sweet clover, burdocks and thistles and the machine cut them down as easily as it would grass. One division of the road has a bracket pole line and on that a device

"The Analysis of a Hydro-Electric Project"

Total production of common brick in U. S. in 1907 was 9,795,698 M.

LETTERS TO THE EDITORS.

A Method of Checking Level Notes.

Sirs: In your issue of Aug. 19 you show the following method of checking "levels":

First HI — Last HI = D_1 .

First Elev. — Last Elev. = D_2 .

First BS — Last FS = D_3 .

$D_1 - D_2 = D_3$.

I assume that the method given is for a check of level notes, and not levels, as the only check of levels possible is to run check levels.

The formula given is correct, but at the same time it is no check on your notes, as there is no way from the formula to detect an error of addition or subtraction intermediate between first and last readings. To cite a concrete example, we will take notes given in method published, which were as follows:

Left hand page.				Right hand page.	
Sta.	B. S.	H. I.	F. S.	Elevation.	Remarks.
.....	3.250	103.250	..	100.000	On hub.
.....	0.250	102.250	1.250	102.000	On rock.
.....	2.070	101.200	3.120	99.130	On rock.
.....	..	..	3.160	98.040	On rock.
From formula given, $D_3 = 0.090$.					

Suppose in figuring notes an error of 1 foot had been made in second elevation and it had been called 103.000 instead of 102.000. This is a common error in figuring level notes. Then this error of 1 foot would have been carried straight through the notes and all HI's and elevations after the first one would have been just 1 foot too high, and the result would be that D_3 would still equal 0.90 of a foot and would be equal to $D_1 - D_2$, although there would be an error of 1 foot all the way through the notes. The result would be same, no matter what error had been made, provided error had not been made in figuring the last elevation, in which case D_2 would not equal $D_1 - D_2$.

I know of no method of checking level notes, excepting by adding or subtracting the difference between the sum of the back sights and the sum of the fore sights to the first elevation, to obtain the last elevation. If there is any shorter method of checking level notes than this, a publication of same would be greatly appreciated by many who are using this method.

Sincerely,

Salem, Ill.

J. S. McBRIDE.

Sirs: On page 122 of the Aug. 19 number of ENGINEERING-CONTRACTING you give a method of checking "levels" for which you say you are indebted to Mr. J. McLane Tate. I suppose you mean a method of checking level notes, as the only way to check levels is to run them a second time or obtain the difference of elevation in some other way.

As to Mr. Tate's method, I should say it way a very uneconomical scheme, as it uses four subtractions for the purpose of check-

ing one addition and one subtraction. For the addition of the first B. S. to the first elevation and the subtraction of the last F. S. from the last H. I. are the only operations checked and one could make any number of mistakes in between without being detected by this method.

For instance, on the accompanying sheet (Fig. 1) the same notes given in the article under discussion were used, but an error was purposely made in computing them. You will note that Mr. Tate's method still "checks," while the proper method of comparing the difference between the sum of the back sights and the sum of the fore sights with the difference in elevation indicates at once that an error has been made in the notes.

The use of the "Rod" column (see Searles and others) makes it possible to separate the side shots from the front

the method of checking levels as given in your issue of Aug. 19. For example, take the sample page of notes as given (Fig. 2) and assume an error in subtraction as shown. Apply the method given and there is an apparent check on the operation.

W. J. SCOFIELD.

Fort Dodge, Ia., Aug. 25, 1908.

Sirs: Referring to your issue of Aug. 19, page 122:

Sta.	B. S.	H. I.	F. S.	Elev.
....	3.250	103.250	..	100.000
....	0.250	101.150	1.250	101.900
....	2.070	99.910	3.120	97.930
....	..	..	3.160	96.750
				3.250
				3.160
	3.340	3.250		.090
	3.250			

.090

Q. E. D.

Use paging as shown below with an independent column for sights on turning points. At foot of each column add up fore and back sights; take the difference and add to the starting elevation, or subtract from, according as the back or fore sights are the greater.

(Elevation of starting point) + (the algebraic sum of sights on the turning points) = final elevation.

sights on turning points, so that the latter can easily be added up for the application

Left.						Right.	
Sta.	B. S.	H. I.	F. S.	Rod.	Elev.	Hub.	
B. M.	3.250	103.250	....	....	100.000	Rock.	
Θ ¹	0.250	101.250	1.250	....	101.000	Rock.	
Θ ²	2.070	100.200	3.120	....	98.130	Rock.	
Θ ³	5.570	.....	3.160	....	97.040		
Sum of F. S. s = 7.530					2.960		
Sum of B. S. s = 5.570							
Difference 1.960 = True difference of elevation. We have an error of 1.000 in the notes. Mr. Tate's Method.							
First H. I.	.....	103.250					
Last H. I.	.....	100.200					
		D =	3.050				
First Elev.	.....	100.000					
Last Elev.	.....	97.040					
		D ₂ =	2.960				
First B. S.	.....	3.250					
Last B. S.	.....	3.160					
		D ₃ =	0.090				
D ₁ - D ₂ = D ₃							
3.050 - 2.960 = 0.090							

Fig. 1.

of the only method of checking level notes excepting the laborious one of recomputing each step.

Very truly yours,

FRED ASA BARNES.

Ithaca, N. Y., Aug. 21, 1908.

Sirs: I think you will find some error in

"A good wine needs no bush."

"ROMAN."

Natchitoches, La., Aug. 23, 1908.

Sta.	B. S.	H. I.	F. S.	R.	Elev.
B. M.	3.250	103.250	..	..	100.000
6	..	..	..	3.2	100.0
+75	..	..	..	5.1	98.1
T. P.	0.250	102.250	1.250	..	102.000

Sta.	B. S.	H. I.	F. S.	Elev.
00	3.25	103.25	..	100.00
00	0.25	102.25	1.25	102.00
00	2.07	101.30	3.12	99.23
			3.16	98.14
First H. I. = 103.25				
Last H. I. = 101.30				
100.00 = 1st. Elev.				
98.14 = Last Elev.				
D ₁ = 1.95				
D ₂ = 1.86				
0.09 = D ₃				
First B. S. = 3.25				
Last F. S. = 3.16				
0.09 = D ₃				

Fig. 2.

1	1.4	100.8
2	4.7	97.5
T. P. 2,070 101,200	3.120	99,130
3	5.6	95.6
T. P.	3.160	98,010

+5,570 —1,960 7,530

100,000 — 1,960 = 98,040.

Q. E. D.

Standard Specifications, Forms, Etc., for New York City.

Sirs: I have been interested in the discussions in your recent issues on standard specifications, catalogs, etc.

fications for curbs, sidewalks, pavements, etc. The committee is thoroughly and exhaustively considering all details pertaining to the subject. The various city departments and all contractors interested have been notified and requested to co-operate with the committees. All suggestions, criticisms, etc., are cordially invited and will receive careful consideration.

All matters are taken up directly with the interested contractors, and the attempt is being made to draft explicit, comprehensive, general specifications which will secure the best ultimate results, considering all practical, commercial, financial,

work slacks up during the winter. While the committee has not arrived at a definite conclusion, it will probably adopt the 8½ x 11 in. size specifications similar to No. 3 in the table. This is the size of the stock letter paper and specifications prevailing in New York city, and seems to be the best standard size suitable to the commercial vertical filing systems now being so generally adopted. The size in the tabulation showing about 8¼ x 10¾ ins. is the 8½ x 11 in. size trimmed down smooth.

In the table the height of capital letters and the number of point type is given as the same. The face of type is cut on a body of metal which measures .0138 in. for

SIZES, GENERAL MAKE UP, ETC., OF SPECIFICATIONS

No.	City or Place.	Com. Mun Engrs.	Width	Length	Sh-Sheets	Bound	Length of Lines	Height of Caps	Type	Paper, Cover, Color, Remarks, Etc.
All Dimensions in Inches.										
1.	Manhattan	8.2	14	E.	5	5	4.3	.10		Paper cover, white. Marginal notes. 40 pages. Nos. top center.
2.	Brooklyn	8.25	14	E.	5	5	4.3	.10		Paper cover, white. Marginal notes. 40 pages. Nos. top center.
3.	Queens	8.5	11	S.	5	4.5	.10			Nos. bottom center. Index in back. Heavy face subheads.
4.	Bronx	8.25	14	E.	5	4.5	.10			Cloth Cover, white and colored. Marginal notes. 72 pages.
5.	Richmond	8.3	14	E.	5.3	4.5	.10			Paper cover, white and colored. Marginal notes. 45 pages.
6.	S. Whinery's Spec.	6	9	S.	4	7	.08			Paper cover, white and colored. Marginal notes. 43 pages.
7.	Chicago	8.25	14	E.	6.15	6	.10			Paper cover, green. Heavy subheads. 56 pages. Nos. top center. Index front.
8.	Philadelphia	8.25	14	E.	6.6	6	.10			Paper cover, white. Heavy subheads. 15 pages. Nos. top center. Index front.
9.	Rochester	7.5	9.25	S.	4.5	6	.10			Paper cover, all colors. Marginal notes. 15 pages. Nos. top center.
10.	Cincinnati	8.4	14	E.	6.6	7	.10			Paper cover, orange. Marginal notes. 124 pages. Nos. top center. Everything in one book. Heavy subheads. Index in back. Separate pamphlet of plans.
11.	Baltimore	6.75	8.33	S.	4.3	7	.10			Paper cover, white. Heavy subheads. Marginal notes. 11 pages. Nos. bot. center.
12.	Boston	7.8	10.1	S.	4	5.7	.10			Paper cover, colors. Heavy subheads. 30 pages. Nos. bot. center.
13.	Pittsburg	8.5	14	E.	5	6.5	.10			Paper cover, gray. Marginal notes. 16 pages. Nos. top center.
14.	Cleveland	6.85	8.25	S.	4.7	8.5	.06			Cloth cover, green. H. F. marginal notes. 38 pages. Nos. top center. Separate Pamphlet of plans.
15.	Seattle	8.5	14	E.	7.3	6	.09			Paper cover, colors. 35 pages.
16.	San Francisco	8.5	14	Sh.	6.3	5	.07			Paper cover, white. Heavy subheads. 19 pages. Nos. bot. center. Print one side.
17.	Buffalo	8.6	14	E.	7	6.5	.09			Paper cover, white. Heavy subheads.
18.	Toronto	8.3	10	Sh.	6	6	.10			Paper cover, white. Heavy subheads.
19.	St. Louis	8.5	14	E.	7	4.5	.10			Paper sheets. Marginal notes.
20.	Kansas City	8.5	14	E.	7	4.5	.10			Paper cover, white. 10 pages. Nos. bottom center.
21.	Milwaukee	8.3	14	E.	7	5	.10			Paper cover, red and white. Heavy subheads. 8 pages. Nos. bottom center.
22.	Indianapolis	8.5	14	Sh.	7.3	6	.10			Paper cover, red and white. 9 pages. Nos. top and center.
23.	Washington	8.5	14	E.	6.7	7	.08			Paper sheets, red and white.
24.	Syracuse	8.5	14	Sh.	6.6	6	.10			Paper cover, red and white. 7 pages. Nos. bottom center.
25.	Detroit	8.5	14	E.	6	6.5	.09			Paper cover, red and white. Marginal notes.
26.	Mobile	8.3	14	E.	5.3	6	.09			Paper cover, red and white. Heavy subheads. 5 pages.
27.	New Orleans	8.0	14	E.	6.6	4	.10			Paper cover, colors. Marginal notes. 18 pages. Nos. top center.
28.	Richmond, Va.	8.5	14	E.	7	4	.10			Paper cover, all red. Heavy subheads. 38 pages. Complete spec.
29.	Omaha	8.3	14	E.	6.6	4	.12			Paper cover, white. Heavy underline subheads. 12 pages. Print 1 side.
30.	Atlantic City	8.5	14	E.	6.3	4	.10			42 pages. Nos. top center.
31.	Hamilton	8	13.5	E.	6.5	6	.09			Paper cover, colors. Marginal notes. 33 pages. Nos. bottom center.
32.	New Rochelle	8.5	14	E.	5.3	7	.09			Paper cover, blue. Heavy subheads. 24 pages. Nos. bot. center. Thin paper. Print one side.
33.	Oberlin, O.	8.0	10.8	E.	5.8	5	.10			Paper cover, colors. Marginal notes. 24 pages.
34.	Newcomerstown, O.	8.3	11	E.	6.5	7	.09			Paper cover, colored. Marginal notes. 12 pages. Nos. bottom center.
35.	Rome, Ga.	8.3	10.5	S.	5	6	.10			Paper cover, white. Heavy subheads. 20 pages.
36.	Albany, N. Y.	8.5	14	E.	6.7	5.5	.10			Paper cover, green. 40 pages. Index in back.
41.	N. Y. Bridge Dept.	8.5	10.7	S.	5	4	.10			Paper cover, white. Marginal notes. 10 pages. Nos. top center.
42.	N. Y. Park Dept.	8.4	14	E.	5	4	.10			Paper cover, gray. Marginal notes. 87 pages. Nos. bottom center.
43.	N. Y. Dock Dept.	8.4	14	E.	5	4	.10			Paper cover, white. Marginal notes. 50 pages. Nos. top center.
44.	N. Y. Water Board.	5.25	8	S.	3.9	6	.10			Paper cover, white. Marginal notes. 116 pages. Nos. top center. Index, middle.
45.	N. Y. Aqueduct Com.	8.5	11	S.	4.5	6	.10			Paper cover, blue. Marginal notes. 120 pages. Nos. bottom center. Index in back.
46.	Brooklyn Sewers	8.5	10.9	S.	5	4.5	.10			Paper cover, gray. Marginal notes. 98 pages. Index in back.
47.	(R.T.) Pub. Ser. Com.	5.6	8.5	S.	3.5	6	.10			Cloth cover, white and blue. Marginal notes. 85 pages. Nos. bot. center. Index in back.
48.	L. T. R. R.	8.25	10.8	S.	5.5	6	.10			Paper cover, white and blue. Index back. 200 pages. Nos. bottom center.
49.	N. Y. State Engr.	8.4	9.3	S.	6	6	.09			Paper cover, white. Marginal notes. 86 pages. Nos. bottom center.
50.	U. S. Reclam. Ser.	8	10.3	S.	6	6	.10			Paper cover, white. H. F. Marginal notes numbered. No page Nos. No Index. Index in front. 28 pages. Nos. top center.

As outlined in an article in Engineering Contracting, March 4, 1908, the municipal engineers of the city of New York have appointed a committee on Uniform Highway Practice, to report on uniform standard specifications, forms, methods, etc., for the five boroughs of the city. As secretary of that committee, I have prepared the enclosed tabulation of sizes, and general make-up of various specifications examined, and trust that it may be of interest.

Tabulations have also been prepared, showing the essential feature of the speci-

fications for curbs, sidewalks, pavements, etc. The specifications, forms, etc., are being completed, revised, giving due attention to all details of subject matter, arrangement, phraseology, typography, size, general make up, etc. Owing to the complicating interests involved, the many parties interested, and the desire to give all due deliberation to all details, the matter entails much care, thought and labor; and as the members of the committee have many pressing routine duties to attend to during this time of the year their report will probably not be completed until the

each point number of type. The size of the impression varies with the character of the type, and from the printed letter it is difficult to determine the exact number of point type, but for ordinary type the number of point type is practically the height of the capital letters as measured in hundredths of an inch.

The commonly accepted width for specifications appears to be 8½ ins., but the 14-in. length, end-opening style is being superseded by the letter size book form. It is still an open question as to the best standard size between the 5 to 9 in. width

and the 8 to 12 m. length. There are advantages and disadvantages of any size. A specification about $8\frac{1}{2} \times 11$ ins. seems to be the best size for general office use, but a smaller size has some merit and our committee expects to have printed some of the standard specifications, plans, etc., in pocketbook form for the field use of the engineers, inspectors and contractors.

The whole matter of specifications, forms, catalogs, periodicals, etc., is an important one, and involves details. The subject matter, phraseology, legal form, arrangement, uniformity, general appearance and utility, composition, size, character and spacing of the various kinds of type, length, ruling, and spacing of lines, margins, marginal notes, underlining, heads and sub-heads, size, quality, and color of paper and cover, location of page, number, index, binding, punctuation, proof reading, etc., all require very careful attention and consideration.

There is such a variety of sizes of paper, and such diversity of practice, that it will require considerable united effort and co-operation among manufacturers, publishers, printers, and the various engineering associations to effect the adoption of uniform standards.

I am heartily in accord with the work and objects of ENGINEERING-CONTRACTING, and having had an intimate acquaintance with Mr. Gillette, your managing editor, for the past fourteen years, and knowing his energetic, progressive and fair-minded character, I am confident that your paper will accomplish farreaching results in bringing about better and more equitable relations between engineers and contractors, and in securing more uniformities in specifications, forms, catalogs, and periodicals. etc.

Very truly yours,

E. H. Thomes,
Assistant Engineer of Highways,
Borough City of New York.
New York, N. Y., Aug. 15, 1908.

There were 11 coal briquetting plants in the United States during 1907. The total production as reported to the U. S. Geological Survey was 66,524 short tons, having a value at the plants of \$258,426.

The total production of vitrified paving brick in the United States in 1907 was 876,245 M., the average price per M. being \$11.02. In 1906 the production was 751,974 M. brick, the average price being \$10.45.

The law for the construction of new railways in Italy has finally been promulgated. It provides for the expenditure of \$107,000,000 during the next 16 years and the construction of 992 miles of new roads, as well as the improvements of existing lines. Only \$772,000 is appropriated (outside of the regular budget) for the year 1908-09; but in 1909-10 the amount will be \$8,357,000; in 1910-11, \$13,549,000; in 1911-12, \$12,896,000.

Estimating the Horse Power of Contractors' Engines and Boilers.

The size of an engine is usually expressed in terms of the diameter of the cylinder bore by the length of the piston stroke. In a 6x8 engine, the cylinder has a bore of 6 ins. and the piston has a stroke of 8 ins. This stroke is, of course, just twice the length of the "throw" of the crank arm. Bear in mind, therefore, that the "size of cylinder" as given in catalogue is the bore of the cylinder by the stroke of the piston, and not by the full length of the cylinder.

If a contractor's engine is designed to have a piston speed of 300 ft. per minute, and is using steam with a boiler pressure of 100 lbs., it is an easy matter to deduce a very simple rule for estimating the horsepower of the engine. The following rule is precisely correct when the product of the piston speed, by the mean effective pressure by the mechanical efficiency is equal to 1050; and this is ordinarily the case with contractors' engines having cylinders of 8 ins. or more in diameter.

Rules: To ascertain the horsepower square the bore of the cylinder and divide by four.

Thus, if the engine is 8x8, we have a cylinder bore of 8. Hence, squaring 8 we have 64, and dividing by 4 we get 16, which is the horsepower. This is the actual delivered, or brake, horsepower.

For smaller engines, whose piston speeds are usually less, it is safe to divide the square of the bore by five instead of by four. A 6x6 engine would, therefore, have 7 horsepower.

If the engine has two cylinders (duplex), of course the horsepower is twice that of a single cylinder.

A boiler is usually estimated to give one horsepower for every 10 sq. ft. of heating surface. Hence the horsepower of a vertical tubular boiler is found thus:

Rule: Divide the total heating surface of the tubes and fire box (expressed in square feet) by ten, and the quotient is the horsepower.

The square foot heating surface of a tube is quickly calculated by multiplying the length of the tube in feet by 0.26 and then multiplying by the outside diameter of the tube in inches. Since tubes are ordinarily 2 ins., the total heating surface of the tubes is found by multiplying the number of tubes by their length in feet by 0.52; or, for all practical purposes, take half the product of the number of tubes by the length of tube in feet. To this heating surface of the tubes must be added the heating surface of the fire box, which is ascertained thus: Multiply the circumference of the fire box in feet by its height above the grate in feet and add the square foot area of the lower flue sheet.

The diameter of the fire box or furnace is usually 4 to 5 ins. less than the outside diameter of the boiler. The height of the fire box is usually 2 to $2\frac{1}{2}$ ft.

The amount of coal required for a contractor's boiler is about 6 lbs. per horsepower per hour, or 60 lbs. per horsepower per day of 10 hours. Nearly one gallon of water will be required for each pound of coal. About $2\frac{1}{4}$ lbs. of dry wood are equal to 1 lb. coal, or 2 cords of wood equal 1 ton of coal.

Price of Yellow Pine for Past Fourteen Years.

The "American Lumberman," in its Aug. 22 issue, gives a very complete table of prices of yellow pine lumber of different classes, from which we have selected the prices of two classes only. These prices apply to lumber delivered at points that are reached by a 23 ct. rate (per 100 lbs.) from the mills, and include the 23 ct. freight rate. The prices are as follows:

Year	Timbers No. 1 Dimension 4"x10" to 2"x10"—16'		12"x12"—16'
	\$12.50	\$12.25	\$11.00
1894	\$12.50	\$12.25	\$11.00
1895	12.25	12.00	10.75
1896	11.00	10.75	10.50
1897	12.50	12.25	11.00
1898	13.50	13.25	12.00
1899	13.50	13.25	12.00
1900	14.50	14.25	13.00
1901	15.50	15.25	14.00
1902	16.00	15.75	14.50
1903	16.00	15.75	14.50
1904	16.00	15.75	14.50
1905	17.50	17.25	16.00
1906	21.00	20.75	19.00
1907	22.25	22.00	20.25
1908	17.75	17.50	16.25

Automatic locks have recently been installed in a dam on the River Weser, near Bremen, according to a recent Consular Report, which gives the following account of the matter: Through the constant deepening of the bed of the Weser on its lower course, the water level upstream having been lowered so much as to cause damage to the adjoining farming country, the Free State of Bremen found it necessary to build a dam at Hemelingen, near Bremen, for the purpose of conserving the water levels of the upper Weser. This dam is provided with two locks, measuring 350 by 12.5 meters (1,148.3 by 41 ft.), and 70 by 12.5 meters (228 by 41 ft.). The opening and closing of these locks is to be done automatically by an ingenious device which utilizes directly the fall of the river without the aid of power machines.

The number of persons as reported to the Interstate Commerce Commission as on the payrolls of the railways in the United States on June 30, 1907, was 1,672,071.

During the year 1907 the testing department of the city of Chicago, Ill., inspected 23,000 tons of water pipe, of which 15,145 tons were accepted. The cost of the work amounted to 11.12 cts per ton inspected.

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are. First, to inform civil engineers and contractors of the articles and papers of merit that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

- American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.
 American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
 American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.
 American Engineer and R. R. Journal (Am. Engr. & R. R. J.), New York, N. Y.; m; 7x10 in.; 20 cts.
 American Gas Light Journal (Am. G. L. J.), New York, N. Y.; w; 10x13 in.; 10 cts.
 American Institute of Electrical Engineers Proceedings (Am. I. of E. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
 American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.
 American Society of Civil Engineers Proceedings (Am. Soc. C. E. Proc.), New York, N. Y.; m; 4x7 in.; 75 cts.
 American Society of Mechanical Engineers Proceedings (Am. Soc. M. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
 Annales des Ponts et Chaussées (An. P. & C.), Paris, France; m. Architects and Builders Journal (Arch. & Bldrs. J.), Baltimore, Md.; m; 9x12 in.; 20 cts.
 Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
 Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
 Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
 International Railway Congress Bulletin (Int. Ry. Cong. Bul.), Brussels; m; 50 cts.
 California Journal of Technology (Cal. J. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
 Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x19 in.; 20 cts.
 Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
 Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
 Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
 Canadian Mining Journal (Can. Min. J.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
 Canadian Municipal Journal (Can. Mun. J.), Montreal, Que.; m; 6x10 in.; 10 cts.
 Canadian Society of Civil Engineers Proceedings (Can. Soc. C. E. Proc.), Montreal; m; 4x7 in.; 50 cts.
 Carpenter and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
 Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
 Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
 Cement Age (Cem. Age), New York, N. Y.; m; 4x7 in.; 10 cts.
 Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
 Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
 Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
 Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
 Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
 Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
 Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
 Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
 Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
 Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
 Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
 Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
 Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
 Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
 Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
 Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
 Electric Railway Journal (Elec. Ry. J.), New York, N. Y.; w; 7x10 in.; 10 cts.
 Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
 Electric Traction Weekly (Elec. Trac. Wkly), Cleveland, O.; w; 7x10 in.; 10 cts.
 Engineer (Engr. Lon.), London, England; w; 4x11 in.
 Engineer (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
 Engineer (Eng.), London, England; w; 8x11 in.
 Engineers' Club of Philadelphia Proceedings (Engr.' Club, Phila. Proc.), Philadelphia; qr; 4x7 in.; 25 cts.
 Engineering-Contracting (Eng.-Contr.), Chicago; w; 7x10 in.; 10 cts.
 Engineering Digest (Eng. Dig.), New York; m; 5x8 in.; 20 cts.
 Engineering and Mining Journal (Eng. & Min. J.), New York; w; 7x10 in.; 15 cts.
 Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
 Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
 Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.
 Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
 Le Genie Civil Paris, France; w.
 Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.
 Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
 Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.
 Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; \$1.
 Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.
 Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
 Iron Trade Review (Iron T. Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
 Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
 Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
 Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
 Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.
 Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
 Journal of Electricity, Power and Gas (Jl. Elec. P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
 Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
 Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
 Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
 Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.
 Mining and Scientific Press (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
 Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
 Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
 Modern Machinery (Mod. Mch.), Chicago, Ill.; m; 7x10 in.; 10 cts.
 Municipal Journal and Engineer (Mun. J. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
 Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
 Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
 Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.
 Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
 The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 in.; 15 cts.
 Power and Engineer (Pwr. & Engr.), New York; m; 7x10 in.; 20 cts.
 Railway Age Gazette (R. R. Age. Gaz.), New York; w; 8x11 in.; 15 cts.
 Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
 Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
 Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
 Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
 Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
 Roadmaster and Foreman (Rd. & For.), Chicago; 7x10 in.; 10 cts.
 Rock Products (Rk. Prod.), Chicago, Ill.; bi-w; 9x11 in.; 10 cts.
 Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
 School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr; 4x7 in.; 50 cts.
 Schweizerische Bauzeitung, Zurich; w.
 Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
 Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
 Sibley Journal of Engineering (Sib. J. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
 Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
 Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
 Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.
 Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.
 U. S. Department of Agriculture Bulletin (Dept. Agr. Bul.), Washington, D. C.; 4x7 in.
 U. S. Geological Survey Bulletin (Geo. Surv. Bul.), Washington, D. C.; 4x7 in.
 Waterproofing and Fireproofing (W. P. & F. P.), New York, N. Y.; m; 5x8 in.; 10 cts.
 Zeitschrift d. Oest. Ing. u. Arch. Ver. Vienna; w
 Zeitschrift d. Ver. Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Tree Planting in Streets. By C. Chambers Smith. The Surveyor, July 21, 1908; 1½ pp.

A brief description of the methods employed in Sutton, England, together with notes on the selection of trees, methods of planting and cost.

Planting Street Trees. By W. W. Pettigrew. The Surveyor, July 24, 1908; 1½ pp.

Describes the selection and planting of trees on streets in Cardiff, England, and gives a list of suitable trees.

Surface Treatment of Roads With Reference to Dust Laying. By Reginald Brown. The Surveyor, Aug. 7, 1908; 1½ pp.

Describes briefly methods of treating road surfaces by watering, tar painting, oil tarring and treating with akonia, calcium chloride, balmitte and pulvicide. General figures of costs for the several methods of treatment are given.

Motor Cars and the Dust Nuisance. By Ralph Oakes. The Surveyor, Aug. 14, 1908; 1½ pp.

In this article the construction, the speed and power of motor cars are considered as factors in producing the dust. Special taxation is suggested as a method for restraining the building of high-speed cars. It is also suggested that changes be made in the construction of the cars, by raising the body, by increasing size of tires, and by increasing diameter of wheels.

Town Planning. by William Harkur; **Town and Street Planning,** by Raymond Unwin; **Street and City Planning,** by Henry Mitchell Whitley. The Surveyor, Aug. 14, 1908; 4½ pp.

The above three papers were read before the Engineering and Architecture section of the Royal Sanitary Institute. The first paper deals with the general laying out of new towns and includes details of the special legislation obtained by Cardiff, England, enabling its corporation to deal with the matter of town planning. The third paper deals mainly with the laying out of the streets. The papers, in general, treat mainly of the laying out of new towns as suburbs to existing cities.

The Cost of Repairing Asphalt Pavements in Utica, N. Y. Eng. Rec., Aug. 29, 1908; ½ p.

The cost of repair work is given in tabular form, and the age of the pavement is listed.

A Bacteriological Method of Determining the Efficiency of Street Cleaning. Eng. Rec., Aug. 8, 1908; ¾ p.

Tells of the experimental use of the squeegee for cleaning smooth pavements, and the method of determining the efficiency of the machine for cleaning by exposing culture plates before and after cleaning. Also gives the amount of water used per sq. yd. with the squeegee.

Concrete Paving for Streets. Eng. News, Aug. 20, 1908; 1 pp.

This article is a summary of experience with concrete pavement in a number of American and Canadian cities. Specifications are given for granitoid pavement as estimated by R. S. Blome, of Chicago, and for paving work in Grand Rapids, and the general construction in the other cities listed is given. General costs are given in a number of instances. A good general article recording current practice.

Gravel and Macadam Roads and Their Costs. By G. C. Houston. Proceedings Indiana Engineering Society (Charles Brossmann, Secretary, Indianapolis, Ind.) 50 (Oct., 1908; 10 pp.

This article, though general in character, gives some interesting information on the construction of gravel roads in Southern Indiana. General figures of cost for some of the roads are given.

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SEWERS.

Investigations of the Distribution of Sewerage upon Trickling Filters. By S. DeM. Gage. Eng. News., Aug. 29, 1908; 5½ pp.

The investigations summarized in this article were much "to determine the fundamental principles which underlies the action of different types of sprinklers in order to ascertain by what combination of these principles we shall be able to obtain the most perfect distribution of sewerage upon the surface of a filter." The several forms of sprinklers listed are illustrated and the results of the tests of each are given. The article is one of decided value to sanitary engineers.

Method of Excavating a Sewer Trench in Water Soaked Sand, Using the Bleeding Method of Unwatering the Soil with Some Estimates of Cost. Eng. Contr., Aug. 5, 1908; 22/3 pp.

Describes in some detail method of unwatering water soaked sand by sinking well points and pumping. The methods enabled a sand which flowed to be trenched some 22 ft. deep with ordinary sheeting. Costs are given of the principal items of work. A notably suggestive article to contractors and engineers having wet excavation to do.

Lowering a 24-in. Water Main in Street Grade at Detroit, Mich. By W. F. Ward. Eng. News., Aug. 13, 1908. 1½ pp.

Describes method of lowering 688 ft. and of relaying 149 ft. of water main to form a dip under a overhead railway crossing and gives quantities, gang worked, wages, etc. Contains some good data not well analyzed.

Steam Pollution Decisions. Mun. Jl. & Eng. Aug. 19, 1908; 1½ pp.

Abstract of court decision regarding the pollution of the Passaic River by the city of Paterson, N. J., and the awarding of damages for the same. The second case is a decision regarding the pollution of a river by the discharge into it of sewage from a hosiery mill.

Utilization of Residuals from Refuse De-structors. By W. J. Steele. The Surveyor, July 24, 1908; 3 pp.

Discusses the methods of disposing of the residue of burnt refuse. Some data are given on the use of the clinker and ashes as a substitute for stone, and in the making of concrete slabs for footways, and the construction of paving setts.

Coalesce Fuel: Utilization of House Refuse. By Herbert Coales. The Surveyor, Aug. 7, 1908; 1½ pp.

A paper suggesting that house refuse be disposed of by converting it into fuel briquettes—called coalesce—and utilized in the production of heat. By the methods, after the refuse has been pulverized in a dust manipulator, tar is added in the proportion of about 18 gallons to the ton. The author states that the approximate cost of converting ashbin refuse into coalesce fuel, including labor, power, tar, wear and tear and loan charges, is calculated at about 4s per ton. And he adds that coalesce fuel may be taken as having an average calorific value of one-third that of best coal.

Laying Water Mains Under Water. Mun. Jl. & Eng., Aug. 12, 1908; 1 p.

Describes methods employed at Vancouver, B. C., in laying a 12-in. main across an inlet 1,200 ft. wide and 65 to 75 ft. deep at the deepest point. The pipe was connected up on shore and drawn across the inlet by cables.

Laying Submerged Force Main at Salem. Mun. Jl. Eng., Aug. 5, 1908; 1 p.

Describes method employed in laying 30-in. main in a trench across a ship channel, 1,500 ft., in water 4 to 35 ft. deep.

Wet Excavation of a Sewer Trench. By C. M. Ripley. Min. Jl. & Eng., Aug. 26, 1908; 4 pp.

Describes the method employed in trenching through a swamp underlaid with quick-

sand for a section of the Gary, Ind., sewer system. The first part of the trench was excavated by a scraper bucket elevator. After this the ground water was removed by the so-called "bleeding method," by sinking a series of connected wells and pumping. Some data on the operation of the diag scraper bucket elevator are given, as are data on the cost of the work.

Sewer Pipes and Joints. Mun. Jl. & Eng., Aug. 26, 1908; 1½ pp.

Describes the English practice of securing water-tight joints. Special methods and forms of pipe are described. Among the joints described are the Stanford composite joint, Hassall's joint, Doulton's grouted composite joint, Brandsan's joint, and the "Jennings jointer."

Cost of a Large Brick Sewer at Gary, Ind. By E. M. Schellow. Eng. Rec., Aug. 29, 1908; 1 p.

A description of the sewer is given, and the cost of excavation, sheeting, pumping, hauling materials, backfilling and other work is listed.

WATER WORKS AND HYDRAULICS.

Air Lift Experiments. Min. Jl. & Eng., Aug. 19, 1908; 1½ pp.

Describes some tests made by the Westinghouse Air Brake Co. at Wilmerding, Pa., to determine the air required and other conditions connected with the raising of water by air lift.

History and Description of Capetown Waterworks. By R. O. Wynne-Roberts. The Surveyor, July 24 and 31, 1908; 13 pp.

This article describes the waterworks of Capetown, South Africa, from the construction of the first reservoir in 1662 down to the present time. The article is general in character, the most interesting feature perhaps being a description of the Kloof Nek reservoir. This is circular in plan, having an internal diameter of 162 ft. and a depth of water of 24 ft. This reservoir was constructed of concrete and drawings of it are shown.

The Water Supply of Basingstroke. By F. R. Phipps. The Surveyor, July 31, 1908; 9 pp.

A general article describing the waterworks of Basingstroke, an English town of 11,000 inhabitants. The principal feature of the article is a description of the pumping plant, which is operated by suction gas.

Sewage and Water Supply Table. Mun. Jl. & Eng., Aug. 19, 1908; ½ p.

A table giving the flow of sewage or flow-off of drainage areas in cubic feet per minute corresponding to various rates in gallons of water consumption per day for various numbers of populations.

The Purification of Water by Sand Filtration. By William B. Fuller. Proceedings Connecticut Society of Civil Engineers (J. Frederick Jackson, Secretary, New Haven, Conn.), 1908; 18 pp.

Describes in a general way slow sand and mechanical filters, and describes the methods employed in cleaning the sand of these filters. A considerable portion of the article is devoted to a description of the washing of sand by the Blaisdell Washer, and several illustrations are given, showing the method of working this machine.

The Underground Water Supply of Indiana. By F. G. Clapp. Eng. Rec., Aug. 8, 1908; 3 pp.

A paper read before the Indiana Waterworks Conference. Results of investigations made in 19 counties in the central and northern parts of the state are given. The water is classified under headings, the titles of which are taken from the strata from which the water is derived. The waste of well water is discussed and the need of legislation to prevent it is shown. Reference is made to laws of other states regarding flowing wells.

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The Hydro-Electric Development and Transmission Lines of the Canadian Niagara Power Co. By A. H. Vancleve, M. Am. Soc. C. E. Proc., Aug., 1908; 40 pp.

A description of this plant and an account of the methods used in constructing the power, house, wheel pit, tunnel and transmission lines. The installation of the hydraulic and electrical machinery is also described.

A Formula for Calculating Flashboards for Dams. By Richard Muller, Aug. 22, 1908; ½ p.

Gives a formula used on the Essex dam at Lawrence, Mass., showing where the Wayne iron pins used to fasten the flashboards to the dam will bend.

The Flow of Water in Spiral Riveted and Other Pipes. By E. W. Schoder and H. A. Gehring. Eng. Rec., Aug. 29, 1907; 1 p.

The writers have had the opportunity of measuring the flow of water in pipes and present the results of their labors in this article in tables and diagrams.

Steam Flow Data With Reference to Water Power in Connecticut and Vicinity. By Charles E. Chandler. Proceedings Connecticut Society of Civil Engineers (J. Frederick Jackson, Secretary, New Haven, Conn.), 1908.

The greater part of the article is devoted to tables giving data of stream flow in the form of second-feet per square mile for a number of rivers. Five of the tables are devoted to stream flow of the Croton river, records of which have been kept since 1868. Stream flow records are also given of the Sunbury river, the Nashua river, the Merimac river and the Connecticut river. The tables are arranged in convenient form; for example, in the Croton river flow records, Table 1 gives the seconds reduced to second-feet per square mile, arranged chronologically; Table 2 gives the same records with the monthly flow of each year, arranged in order of magnitude; Table 3 gives the same records with the monthly flows of the whole term arranged in order of magnitude; Table 4 compares the results of the three methods of averaging, and Table 5 averages and masses the duration of each rate of flow.

DRAINAGE AND IRRIGATION.

Reconnaissance of Irrigation Systems With Some Cost Data on the Crow Reservation Project, Montana. By J. C. Cleghorn. Eng.-Contr., Aug. 19, 1908; 1½ pp.

Describes character of reconnaissance work and methods of performing it, and gives organizations of party, wages paid and cost per mile of several surveys made for Crow Reservation project in Montana.

The Damming of the Murrumbidge River, Australia. By C. O. Burge. Eng. Rec., Aug. 8, 1908; 1 p.

Describes the work that is to be done in building this large dam for irrigation purposes. A short description is given of the Roosevelt dam in Arizona and the Assuan dam in Egypt to allow of comparison. These three being the largest dams in the world for irrigation purposes.

The Prevention of Seepage From Ditches and Canals. Eng. Rec., Aug. 29, 1908; 2 pp.

An account of investigation made by the Agricultural Experiment Station at Berkeley, Cal., on the seepage of water from irrigation ditches and canals, showing the per cent of water that is wasted in this manner, and also on methods of preventing this waste. Some costs of lining ditches are also given.

RIVERS, HARBORS AND CANALS.

Two Types of Sea Wall for Land Filling, New York City. Eng. Rec., Aug. 22, 1908; 1 p.

A description of the two sea walls being built by the Department of Docks and Fer-

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RAILWAYS.

Methods and Cost of Mountain Railway Location. By J. J. Cryderman, Eng.-Contr., Aug. 5, 1908; 4½ pp.

A general article discussing methods of procedure, organization, housing, feeding and caring for party, and wages and cost. The author gives numerous practical hints and suggestions which have developed from his experience.

Tramway Rail Joints. By Alfred H. Gibbings, The Surveyor, Aug. 7, 1908; 6½ pp.

A paper read before the Annual Congress of the Tramways and Light Railway Association of Great Britain. In it the author describes briefly some of the modern forms of rail joints for tramway track. The three modern systems of electric traction as applied to street railways, viz., electric trolley, electric and cable conduit and electric surface-contact systems, are considered. The article takes up the following subjects: Permanent way, rails, fishplates, modern joint devices, soleplates, welded joints, anchors, forged rail ends and bonding. Numerous illustrations showing the various types of construction are included.

East River Tunnel From South Ferry to Joralemon Street. By F. C. Noble, Mich. Technic, June, 1908; 12 pp.

Reviews the history of tunnel projects under East river and of this particular tunnel used for the subway. Describes the plan, the preliminary work, and the methods of constructing, giving an account of the difficulties encountered. The tunnel was partly through rock and partly in soft mud and sand.

Reconstruction of Street Railway Track at Charlotte, N. C. Eng. News, Aug. 6, 1908; 11-6 pp.

Gives structural details of track, consisting of T-rails supported on chairs on longitudinal concrete beams. Construction is considered to avoid usual disadvantages of T-rails for street railway work. Particular mention is made of the chairs, tie-bars, anchors and longitudinal expansion joints.

Progress on the Subway Loop, New York. Eng. Rec., Aug. 15, 1908; 3 pp.

A description is given of the work to be done and the outfit being used. Also the methods being employed and the progress that is being made.

BRIDGES, BUILDINGS AND FOUNDATIONS.

Design of the Quebec Bridge; Report by C. C. Schneider, With Theodore Cooper's Specifications. Eng. News, Aug. 6, 1908; 2½ pp.

Abstract of special report to Canadian Government on the design of the Quebec bridge. The specifications governing the original design of the bridge are given and the following subjects discussed: (1) The sufficiency of the present plans of the Quebec bridge as to their conformity to the specifications as approved by the government; (2) the advisability of modifications in the present plans, using as far as practicable the fabricated material now on hand; (3) the advisability of discarding the present plans and recommendations as to new designs. The abstract necessarily gives a bare summary of the report.

High Speed Elevators. By W. W. Lightpipe, Sch. Min. Quart., July, 1908; 7 pp.

A paper read before the Electrical Engineering Society of Columbia University. States that twice as many passengers are carried on vertical elevators in a day in New York City as are carried by all the

subway, surface and elevated cars. Then reviews the various types of electrical elevators that have been used, and describes the principle of the rapid travelling type of elevator now used in the tallest buildings in New York. A very interesting paper.

Cost of Piers of the Chattahoochee River Viaduct. By John W. Ash, Eng. Rec., Aug. 29, 1908; 1½ pp.

An account of the building of the substructure of this bridge with the methods used and the detail cost of the excavation and concrete work.

A Quick Change of Traffic on a Railroad Draw Bridge. Eng. Rec., Aug. 22, 1908; ½ p.

A description of the method used to substitute a Scherzer roller lift bridge for an old swing draw bridge on the Norfolk & Western R. R. near Norfolk, Va.

The Suspended Falsework for the Manhattan Bridge. Eng. Rec., Aug. 8, 1908; 3 pp.

A description of the falsework that is to be used in constructing the main cables of this bridge in place, illustrated by photographs and drawings.

The Mulberry Street Viaduct, Harrisburg, Pa. Eng. Rec., Aug. 15, 1908; 3 pp.

A description of the design of this concrete viaduct, more than 1,800 ft. long, is given, with the methods that are being used in building it. This viaduct replaces a steel bridge that was built many years ago. Illustrated by a number of drawings.

A Steel Frame Hay Barn. Eng. Rec., Aug. 15, 1908; 2 pp.

A description is given of the design and erection of this barn, built of structural steel. This is said to be an unusual use for steel. Illustrated with drawings and a photograph.

Deep Building Foundation in Chicago. By James N. Hatch, Mich. Technic, June, 1908; 6 pp.

This article describes the work of demolishing an old building, and the building of a new skyscraper. The foundation work, caisson, was started while the old building was still occupied. The method of doing the work is described, and drawings show the various stages of work. The use of the system of freight carrying tunnels under the streets of Chicago is shown in connection with the work.

The Sinking of the Piers for the Grand Trunk Pacific Bridge at Fort William, Ontario, Canada. By H. L. Wiley, M. Am. Soc. C. E. Proc., Aug., 1908; 7 pp.

These piers were made by sinking steel shells to bedrock and then filling them with concrete. A description is given of the methods of sinking the shells and of placing the concrete. One pier was for use as the center pier of a swing bridge.

CONCRETE AND REINFORCED CONCRETE.

Tests on Bonding New Concrete to Old. By R. B. Perry, Eng. News, Aug. 13, 1908; ½ p.

Describes series of tests made at the Case School of Applied Science to determine efficiency of various methods of bonding new concrete to old. The author draws the following conclusions from the tests: (1) The bond existing between new mortar or concrete and old, when the old surface is smooth, is very slight; (2) about one-half of the strength of the concrete is developed in a joint bonded (a) by roughening the old concrete, (b) by applying a layer of cement paste, (c) by providing the old surface with a bonding groove; (3) a large part of the strength of the concrete, perhaps as much as 90 per cent, is developed where the old surface is roughened and a layer of cement paste is applied (4) such a solution as "Ransomite" practically takes the place of rough-

Cements, Mortars and Concretes

—Their Physical Properties

An up-to-date Compendium of Reliable Tests of Cements, Mortars and Concretes

By

MYRON S. FALK, Ph. D.

Instructor in Civil Engineering, Columbia University.

This book contains a very complete report of the results of tests made during the past fifteen years, and gives these results in tables and diagrams classified according to subjects. This is a reference book that should be in the library of every civil engineer. The contents include chapters on Chemical Properties of Cement, Physical Tests of Cement, General Physical Properties, Elastic Properties in General, Tensile Properties, Compressive Properties, Flexural Properties, Report on Uniform Tests of Cement by the Special Committee of the American Society of Civil Engineers, and Constitution of Cement.

Cloth, 6x9 inches; 184 pages; illustrated; price \$2.50 net, postpaid.

Practical Cement Testing

By

W. PURVES TAYLOR, M. S. C. E.

Engineer in Charge of Philadelphia Municipal Testing Laboratories.

This is the first practical and exhaustive treatise on this important subject. It has already been adopted as a text-book by the University of Pennsylvania and other technical schools. Each chapter contains a minute description of the methods followed in the author's laboratory and many valuable suggestions as to the "how" and "why" of cement testing. The observations on the interpretation of results, one of the most difficult tasks of the novice, are especially pertinent and are expressed in a fair and conservative manner.

The book is so complete that it can be put in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of text are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, M. S. C. E.; Am. Soc. Test. Mts.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6x9 inches; 330 pages; 142 illustrations; 58 tables; \$3.00 net, postpaid.

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355 Dearborn St., Chicago

ening, since a bond made with it is otherwise similar to the one made in these tests by roughening the old surface and applying a layer of cement paste.

Some Methods Employed in Constructing the 7½-Mile Reinforced Concrete Aqueduct for the Water Supply of Salt Lake City. Eng.-Contr., Aug. 5, 1908; 2½ pp.

Shows section of aqueduct, special details, details of forms and views of plant arrangement, and describes the general methods of work, the design of forms and method of handling them. Some general costs are given.

Methods and Labor Cost of Constructing Over 200 Concrete Vaults for Underground Conduit. Eng.-Contr., Aug. 12, 1908; 2½ pp.

Shows details of vaults and of the removable forms used, describes general methods of construction, and gives in tabular form itemized cost of 218 concrete vaults divided into seven groups of from 11 to 58 vaults each. The article is notable in that the costs are based on very carefully kept records and for the number of vaults included. One of the facts brought out is the superior economy of removable forms.

Tests of Bond of Steel Embedded in Reinforced Concrete Beams. Eng.-Contr., Aug. 12, 1908; 2 pp.

Gives results of tests made at the laboratories of the University of Wisconsin. The following conclusions are drawn: (1) The bond of 1:2:4 concrete to embedded steel increases with age at least up to six months. About 80 per cent of its six months bond strength is developed at 28 days. (2) Owing to the variation in results of the one-month tests and the wide difference between laboratory experiments and practical working conditions, it does not seem as though the maximum bond of 1:2:4 concrete should be assumed greater than 200 or 250 lbs. per square inch in designing. (3) The method of making bond tests by pulling a rod from a concrete cylinder, as previously described, gives results which are of neither quantitative nor qualitative value. The results obtained are dependent largely upon compressive stress acting on the head of the cylinder. (4) The beam test for bond on the other hand approaches closely the actual conditions to which the bar and surrounding concrete are most often subjected, and gives values which are at least of qualitative value. Furthermore, values obtained by this method are in accord with the bond theory usually accepted as a basis in design.

Factory-Made Concrete. By C. D. Watson. Eng.-Contr., Aug. 19, 1908; 2½ pp.

An argument in support and proof of the superior advantages of reinforced concrete building construction of separately molded members. The article presents its subject with unusual force and deserves to be read by concrete workers.

The Influence of Fine Grinding on the Physical Properties of Portland Cement. By Richard K. Meade. Eng. Rec., Aug. 15, 1908; 2 pp.

A paper delivered before the American Society for Testing Materials. In it are set forth the results from some carefully made experiments that show the value of fine grinding of cement. The two properties of cement most affected by the fine grinding are the setting time and the sand carrying capacity.

Some Problems in Reinforced Concrete Engineering. By H. Alexis d'O'Saubrey. Aug. 22, 1908; 4 pp.

A discussion of the failure of concrete beams, and the results of the testing of concrete beams tested at the Case School in Cleveland, Ohio, under the supervision of the author. The bonding of the steel and concrete is given great consideration. A few suggestions are made as to the practical value of these tests.

Now Ready

CONCRETE CONSTRUCTION

METHODS AND COST

By

Halbert P. Gillette

*M. Am. Soc. C. E., M. Inst. M. E.,
Managing Editor, Engineering-Contracting*
and

Charles S. Hill, C. E.,

Associate Editor, Engineering-Contracting.

THIS book handles the subject of concrete construction entirely from the view-point of the *builder* of concrete structures. The testing of cement, the physical properties of cements and concrete, and the design of concrete structures are not considered. The aim of the authors has been to eliminate all matter not germane to the constructing end of their subject. By doing this it has been possible to crowd a vast amount of detailed information on methods and cost of concrete construction into a volume of moderate size. The book is a treatise on the *methods and cost* of building in *concrete*.

WHILE concrete design is not considered, no designer of concrete can be a really good designer without having a profound knowledge of costs and of practical methods of construction. This book will be of interest therefore to every engineer and architect who is engaged in designing concrete structures. It should be of particular assistance, however, to the contractor or engineer engaged in the actual work of making and placing concrete.

THE methods given are practical methods and they are so given that the practical man can use them. The costs given are actual costs, itemized, analyzed and reduced to units. Costs of material, costs of transporting, costs of mixing, costs of placing, costs of tamping, costs of finishing, costs of forms, costs of bending and placing reinforcement, costs of waterproofing, costs of superintendence, costs of plant, interest charges, depreciation charges are all given, and to make these costs useful, the conditions and the methods of doing the work are stated in each case.

Cloth, 6 x 9 inches, 700 pages, 306 illustrations, \$5 net, postpaid.

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Bridges and Culverts for Highway Traffic. Expanded Metal and Corrugated Bar Co., St. Louis, Mo. Aug., 1908; 30 pp.

This is the fourth pamphlet in the series that this company is issuing on the designing methods of reinforced concrete construction. Standard designs for box culverts, flat slab bridges, twin culverts and girder bridges are given. The tables covering these designs will be found useful. These bulletins can be had for the asking.

Hydrated Lime and Cement Mortars. By E. W. Lazell. Eng. Rec., Aug. 29, 1908; 1 p.

A paper read before the Am. Soc. for Testing Materials. Gives an account of tests made with mortars made from lime and cement.

Reinforced Concrete Beam Formulas. By A. E. Lindau. Mich. Technic., June, 1908; 3 pp.

A comparison is made of the various formulas in common use in this country for calculating the resistance moment of reinforced concrete beams. It is shown that these formulas are all safe, even with the wide variation in the assumptions upon which they are based.

Cost of Constructing a Reinforced Concrete Dam for Irrigation Work in Wyoming. Eng.-Contr., Aug. 26, 1908; ½ p.

Gives itemized cost on reinforced concrete buttressed dam built by contract, including excavation. General methods of construction are described.

Useful Tables for Estimating the Cost of Concrete and for Designing Reinforced Concrete Beams and Slabs. Eng.-Contr., Aug. 26, 1908; 1 p.

Tables showing quantities of material required, strength and cost of concrete of various proportions, also giving data for quick computation of reinforced concrete beams and slabs.

Cost of Constructing a Small Concrete Culvert for a Highway. Eng.-Contr., Aug. 26, 1908; ½ p.

Shows details of 6-ft. arch culvert with wing walls and gives itemized unit cost of construction.

EARTH AND ROCK EXCAVATION.

Methods and Cost of Earth and Rock Excavation for a Railroad Cut. Eng.-Contr., Aug. 5, 1908; 1 p.

Describes the methods used and gives in detail the cost of each class of work, namely, earth, loose rock and solid rock. The amount of explosives used per cu. yd. is given. The cost of feeding and caring for mules is likewise discussed. An economical method of handling boulders is described and illustrated.

Methods and Cost of Earth and Rock Excavation With a Steam Shovel and the Cost of Repairing a Wrecked Steam Shovel. Eng.-Contr., Aug. 5, 1908; 2½ pp.

In this article is described how a steam shovel was wrecked and the method used in picking up the wreck and repairing it. The cost of this is given. Then two months' work done by the shovel is described and the total cost of the work is given, being also reduced to cost per cu. yd. for earth and for rock. Some costs on a temporary trestle are given. The value of the outfit used on the work is listed.

Some Interesting Records of Excavation at Panama and on the Erie Canal. Eng.-Contr., Aug. 5, 1908; ½ p.

Gives records of excavation made on these two important pieces of work and the equipment with which the excavation is being made, allowing of a comparison of the work being done on the two jobs.

The Cost of Excavating a Culvert Foundation, With Comments on the Methods of Paying for It. Eng. Contr., Aug. 5, 1908; ¾ p.

The cost of digging a wet culvert founda-

tion is given in detail. Suggestions are made that work of this character should be paid for at a higher rate than ordinary grading work.

The Cost of Excavating Earth and Hardpan for a Creek Change, With Comments on the Method Used and Manner of Staking Out the Work. Eng.-Contr., Aug. 19, 1908; 1½ pp.

The itemized cost of doing this work is listed, showing the cost of blasting and excavating hardpan, and also of earth. This is one of the few records of cost of excavating hardpan that has appeared in print. Comments are made showing how the contractor erred in doing the work, and also the mistake made by the engineer in staking out the work.

Comments on Some Records of Hauling Earth in Cars and Dumping With Plows. Eng.-Contr., Aug. 26, 1908; 1 p.

Gives records of cars hauled, with yardage and number of miles traveled a day for several styles of cars used on the Panama canal. Also records of unloading flat cars with a plow.

The Pressure of Earth on Bracing in Trenches. By Milo K. Ketchum. Eng.-Contr., Aug. 26, 1908; 1½ pp.

This is a reprint of a paper delivered before the Am. Soc. C. E. The author assumes that when the cohesion of the earth is overcome the particles of earth act like grain in a bin. On this assumption a formula is given and some diagrams for obtaining the earth pressure in trenches.

The Cost of a Culvert Excavation on a Railroad. Eng.-Contr., Aug. 12, 1908; ½ p.

The itemized cost of the work is given, and comments are made upon the fact that the cost was high, showing how the contractor could have reduced them.

Cost of an Earth Embankment and Gravel Facing. Eng.-Contr., Aug. 12, 1908; ½ p.

The cost of the Whalen earth dike, built by the U. S. Reclamation Service, is given. The cost of the earth work is given separately from the gravel, under the three heads of labor, plant depreciation and superintendence.

MATERIALS OF CONSTRUCTION.

The Preservative Treatment of Loblolly Pine Cross-Arms. By W. F. Sherfese. Forest Service Circular 151; 29 pp.

A very useful circular for all of those interested in crossarms for telegraph and telephone poles. Discusses the seasoning and treating for preservation, the grading of the timber. Also the method of piling the crossarms, and how to protect them from the weather. A very complete discussion of the whole subject.

SURVEYING AND DRAFTING.

State Boundary Survey. By Henry R. Buck. Proceedings Connecticut Society of Civil Engineers (J. Frederick Jackson, Secretary, New Haven, Conn.). 1908; 22 pp.

A general article describing the resurvey and marking of the Massachusetts-Connecticut state line. The article tells much of the early surveys of this line, and also gives a brief account of the field methods used in the present survey.

COST KEEPING AND MANAGEMENT.

Filing System of the New York Board of Water Supply. By L. J. Murphy. Eng. News, Aug. 6, 1908; 4½ pp.

Discusses the purpose of filing sections and their advantages in general, and describes in particular the system adopted by the New York Board of Water Supply, giving subject list and other details. The organization for filing work is also discussed. An excellent article on the organization of a filing system on a large scale.

Importance of Records in Engineering Work. By E. E. Howard. Eng.-Contr., Aug. 26, 1908; 2¾ pp.

An argument on the importance of com-

Handbook of Cost Data

By HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting"

"Cost Data" has broken all records for the sale of technical books. Over 10,000 copies were sold in less than two years; 1,600 in last three months. The book has over 600 pages of actual costs taken from the private records of engineers and contractors, and so itemized and analyzed as to be of inestimable value to any person who has to do with making bids and estimates or in checking estimates. This covers the whole field of contract work, giving the cost of labor and materials required for every kind of construction from the laying of sod to the building of reinforced



concrete sewers. No detail of contract work has been too small to be described and recorded. Wages and prices of material are given in every case, so that proper substitution can be made where conditions differ. It gives also valuable data on methods of construction, thus enabling foreman to handle work in the most economical manner possible.

The general headings are:

- Cost-Keeping, Preparing Estimates, Organization of Forces, etc.
- Cost of Earth Excavation.
- Cost of Rock Excavation, Quarrying and Crushing.
- Cost of Roads, Pavements and Walks.
- Cost of Stone Masonry.
- Cost of Concrete Construction, all kinds.
- Cost of Water-Works.
- Cost of Sewers, Vitrified Conduits and Tile Drains.
- Cost of Piling, Trestling, Timberwork.
- Cost of Erecting Buildings.
- Cost of Steam and Electric Railways.
- Cost of Bridge Erection and Painting.
- Cost of Ry. and Topographic Surveys.
- Cost of Miscellaneous Structures.

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plete and clear records of all details of engineering work. The qualities of a good record are stated and general methods of record keeping are discussed.

Cost of Engineering in City Work. Eng. Contr., Aug. 5, 1908; 1 p.

Gives items of cost of waterworks, sewers, street and road work, organization and engineering compiled from records of Salt Lake City, Utah. A useful record for city engineers.

MISCELLANEOUS.

Portable Compressed Air Plant for Calking Pipe. By A. E. Walden. Eng. News, Aug. 6, 1908; ½ p.

Describes plant, compressed air hammer and calking tool used in calking some 25 miles of 8, 10 and 12-in. water pipe. Records of work done and some account of methods are given.

Joints and Fittings for High Pressure Air. By H. V. Haight. Comp. Air, Aug., 1908; 12 pp.

Describes and illustrates the various joints and fittings used in pneumatic plants used for mining coal in Western Canada. Many details are shown and valves are described.

New Methods of Laying Duct and Building Manholes for Electric Transmission Lines, With Figures of Comparative Costs. By C. Mayer. Eng.-Contr., Aug. 19, 1908; 2 pp.

Describes recent changes in standard reconstruction of conduits, manholes, etc., for underground transmission line, stating advantages gained. Makes special reference to new triangle 3-duct conduit and gives comparison of costs of such duct and old style duct. A valuable article for telephone engineers and others having underground electric transmission line to construct.

Vacuum Pumps. By John C. Bird. Mich. Technic., June, 1908; 5 pp.

A short paper describing and illustrating by drawings the principle of vacuum pumps.

BOOK REVIEWS.

Road Preservation and Dust Prevention.—By William Pierson Judson, M. Am., Soc. C. E. Engineering News Publishing Co., New York City. Cloth 6x9 ins.; 146 pp.; 15 illustrations; \$1.50 net.

Since the destructive effects of automobiles on macadam roads did not reach an acute stage in America until about two years ago, there is very little to be found in existing text books on the treatment of roads to prevent dust or on the building of dustless roads. Hence this little book of Judson's appears at an opportune time, and forms an admirable and necessary supplement to any book on roads which an engineer may now possess. Mr. Judson is well qualified for the task of summarizing the current literature, as well as for expressing authoritative opinions on the subject, for he was several years in charge of all road construction in New York state done by the department of the state engineer.

The book is divided into nine sections or chapters, whose titles are as follows: Road Dust—Its Control and Prevention; Moisture; Oil Emulsions; Oils; Coal-Tar Preparations; Tar-Spraying Machines; Tar-Macadam; Rock-Asphalt Macadam; Bitulithic Pavement.

In each of these sections the author gives a concise description of the materials and methods used, usually accompanied by sufficient cost data to give a good general idea of the cost of doing the work, thus furnishing an excellent compendium of current practice, as well as indicating what the present trend appears to be.

The author quotes Col. Wm. D. Sobier to the effect that "a macadam road, made of stone and bound with rolled screenings and water, has gone out of date," and then adds that this statement was not questioned by any of the hundred or more members of the

The world's authority on this great subject.
The most expensive book ever issued and sold for \$5.00.

Concrete and Reinforced Concrete Construction

By HOMER A. REID; Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; \$5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter—material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

Write for 16-page Table of Contents.

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Massachusetts Highway Association who were present.

Highway engineers even yet are not fully awakened to the import of these statements about the passing of the old macadam road. Millions of dollars must be spent in resurfacing existing macadam roads so they will resist the action of automobiles. Entirely new types of roads are coming into vogue. It is the province of every highway engineer to acquaint himself with what other engineers have done and are doing, and to that end every highway engineer should study this admirable monograph on the subject of road preservation and dust prevention.

Railway Track and Trackwork. By E. E. Russell Tratman, M. Am. Soc. C. E. Engineering News Publishing Co., New York City. Cloth 6x9 ins.; pp. 520; 232 illustrations; 44 tables; \$3 net.

This is the third edition of Mr. Tratman's book, first published in 1897, and of which a second edition appeared in 1901. It is fully revised, contains over 230 illustrations and 44 tables, and a valuable appendix of tabulated standards of track construction on typical American railways. About 50 pages of new matter have been added, and the entire book has been rejuvenated and brought fully up to date.

As the title of the book indicates, it is divided into two principal divisions, the first treating on the details of track construction and track materials, and the second on track maintenance. There are 16 chapters in the first part as against 15 chapters in the second edition, grade crossings forming the subject of a special chapter. Nearly all the chapters have been rewritten and brought up to present practice. The title of the chapter, "Street Railway Track," having been changed to the more comprehensive one of "Electric Railways." The second part, relating to trackwork, has been equally well treated and reflects great credit upon the author for his thoroughness of presenting very accurate details of the work described. In the chapter of "Organization" the description of the duties of the various track officials is very complete, though perhaps the roadmaster does not receive full credit for his knowledge and capacity, being called "a sort of first-class foreman." The majority of roadmasters of to-day are certainly required to possess greater ability and better accomplishments than even a first-class foreman. The duties of section foreman, track walker and watchman are likewise fully enumerated and differ little from the description in the second edition. Master Carpenters and yard masters are classified as minor track officials, but it would seem the master carpenter belongs with the bridge and building department, and the yard master with the transportation department.

The new edition has given "Renewing Rail" a place in the title of a chapter, while renewing ties is classed as general track work. Perhaps in a fourth edition the author may find it convenient to increase the number of chapters considerably, by making separate chapters of subjects, such as Renewing Ties, Surfacing, Gaging, Lining, Fencing, etc.

The chapter on "Signals and Interlocking" has been materially enlarged and gives organization of employees and style of signals on a number of typical roads.

The chapter on drainage and ditching gives very full description of various styles of ditches, but the value of the book could have been enhanced had the descriptions been supplemented by drawings.

Mr. Tratman has been very careful to embody in his book all the new methods and principles which have developed in recent years and it must be admitted that the work

is up to the best practices of the present day in this respect. The writer regrets the elimination of the striking illustrations of the good and the bad spiker. Those pictures in the second edition told the complete story of spiking better than a whole page of reading matter could upon that subject.

The chapter on "Gage, Grades and Curves" has been considerably enlarged, and especially the subject of "Transition Curves" has been completely worked over and new methods described relative to curve easements.

Taken as a whole, the book certainly covers the subject in a thorough manner. It not only includes the general principles of track construction and maintenance, but also sufficient details and data regarding the equipment, appliances and methods as practiced by railways, thus proving the theories by showing them in actual use. There is a tremendous amount of reliable information in the 520 pages of this work, which should make it almost indispensable for every railway official who is at all concerned in the construction or maintenance of railway track. While the various subjects are treated in a technical and concise manner, there is not too much of mathematical formula introduced to weary the practical man; rather the meat in the shape of useful rules, formula and tables is presented ready for immediate use.

Mr. Tratman's Railway Track and Track Work should adorn the library of every maintenance of way official.

Telephone Construction—Methods and Cost. By Clarence Mayer, Formerly Cost Statistician and Facilities Engineer, Chicago Telephone Co., with Appendices (A) Cost of Materials and Labor in Constructing Telephone Line, by J. C. Shippy, Consulting Telephone Engineer, and (B) Miscellaneous Cost Data on Pole Line and Underground Conduit Construction, compiled by the Editors of Engineering-Contracting, Chicago and New York. The Myron C. Clark Publishing Co. Cloth 6x9 ins.; pp. 284; 157 tables; 163 illustrations; \$3 net.

At first glance one is almost appalled by the mass of closely tabulated cost data presented by Mr. Mayer and the others, who have collaborated in the production of this volume. We risk nothing in saying at the outset that no such mass of cost data relating to one type of construction has ever before been printed as is collected in these short 200 pages. As a matter of fact, however, there is a preponderance of straight text and illustrations which make the book easy and really very interesting reading even to one who does not care for the details of cost. To the telephone engineer and the contractor for telephone work the cost data should be of the very highest value.

Referring first to the main part of the book, written by Mr. Mayer, we have here a complete discussion of cost collecting and recording, and methods of estimating costs, and description of structural telephone construction with an explanation of the methods of doing work, and tabulations of actual costs in great detail. The author has divided his treatment of the subject into eight chapters.

Beginning with a presentation of the advantages of cost records to telephone companies and to contractors for telephone work, the author describes in successive chapters, the methods of construction for pole line, aerial and underground cable, cable splicing, removing old line and renewal, underground conduit, and miscellaneous structures. Costs are given for every part of the work; the costs being averaged from actual cost records kept on many hundreds of jobs by specially trained men, using a uniform system and working under the author's supervision.

The costs on conduit work are averaged from actual costs kept on over 250,000 ft of

underground main conduit and laterals and on over 550 vaults. The costs on other classes of work are based on similarly extensive records. Detailed costs of installing one of the largest multiple duct conduits, comprising 824,862 duct feet of conduit and 318 vaults, are given in Chapter VI.

Special attention has been paid to the classification and itemizing of the costs so that they may be used by telephone companies and contractors for telephone work in the preparation and the checking of estimates.

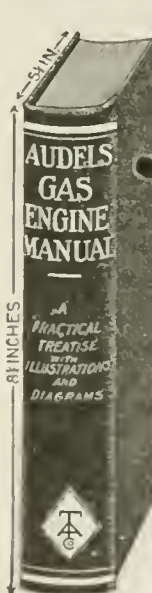
In the chapter on pole line construction, the cost tables not only give costs separately for each size and style of cross arm, wire, anchor, and for each size of pole set in each kind of soil, but, in addition, the tables give costs of each detail of construction work, such as—in the case of poles—cost of teaming, cost of framing, cost of excavating, cost of setting, and cost of supervision. The cost tables given in Chapter V give separately, costs for each number of duct, each kind of soil and each method of constructing main conduit and laterals, and for each size and method of constructing vaults; and, in addition, the tables give costs of each detail of work such as, teaming, excavating, mixing concrete, laying tile, filling in, and supervision. Costs of almost every kind of splice are given in Chapter III. This classification and analysis is carried throughout every division of telephone construction.

The costs are actual construction costs—not contract prices—and have been used by the author for making hundreds of estimates. As the rates of wages, construction methods, and system of collecting and computing the costs are given for each division of telephone construction, the costs may be easily revised for use by telephone companies and contractors for telephone work, even where rates of wages or construction methods differ from those shown in these pages.

In Chapter VIII, the author explains the method of using the costs in making estimates, taking an actual job of large size and working out the estimate in detail, with clear explanations of all considerations to be kept in mind.

The matter in the appendices supplement

GAS ENGINE MANUAL



Q This volume just published gives the latest and most helpful information respecting the construction, care and management of Gas, Gasoline and Oil Engines, Marine Motors and Automobile Engines, including chapters on Producer Gas Plants and the Alcohol Motor.

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Q The only way the practical merit of this MANUAL can be given is by an examination of the book itself, which we will submit to the readers of Engineering-Contracting, free for examination, to be paid for or returned, after looking it over.

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the data given in the main part of the book. In Appendix A the cost records of a large telephone company covering some five years' work have been compiled and averaged. Appendix B gives methods and cost of constructing a number of separate pieces of pole line and underground conduit and is valuable for the practical working hints contained. We can heartily recommend this volume to all interested in telephone and other electric transmission line work as containing an amount of cost data and a mass of practical working instructions not found elsewhere to our knowledge in technical literature.

Cyclopedia of Civil Engineering.—A general reference work covering the field of modern engineering achievement. For the Civil, Structural, Railroad, Sanitary, Irrigation, Hydraulic, and Hydro-Electric Engineer. Prepared by a staff of practical experts of the highest professional standing. Editor-in-Chief, Prof. F. E. Turneure, C. E., Dr. Eng., Dean of the College of Engineering, University of Wisconsin. American School of Correspondence, Chicago, Ill. 10 vols.; 4,000 pp.; 3,000 illustrations; \$21.

The ten volumes of this cyclopedia give remarkably good value for the money. It is text book matter of course that one gets and for the most part text book matter prepared for a special class of readers—the self-instructed home student—but it is clearly put and accurate and notably practical. The engineer who buys the work will no more get the detailed technical treatise on bridges or concrete construction or railway engineering that he gets in his Wellington, Johnson, Reid, etc., than does the purchaser of a cyclopedia of history get his Motley, Greene and Fiske, but he will get a good running treatment of each subject by writers whose scholarship and standing in engineering are exceptionally high. Indeed the list of authors and collaborators is the best guarantee of the quality of the work.

Among the more prominent names we note that of Prof. F. E. Turneure, of the University of Wisconsin, Editor-in-Chief, and author of the sections on Water Supply and Hydraulics; Prof. A. E. Phillips, of Armour Institute of Technology, author of Plane Surveying and Irrigation Engineering, and joint author of Highway Construction; Walter Loring Webb, author of Masonry and Reinforced Concrete, Railroad Engineering, and Plotting and Typography; D. P. Gillette, joint author of Cost-Analysis Engineering; E. A. Tucker, author of Steel Construction; Prof. F. O. Dufour, of the University of Illinois, author of Bridge Engineering and Roof Trusses; Prof. A. Black, of Columbia University, author of Water-Power Development; Prof. C. E. Morrison, of Columbia University, author of River and Harbor Improvement; Prof. A. Marston, of Iowa State College, author of Masonry and Drains, and Chas. R. Ball, Chief Sanitary Inspector of the City of Chicago, joint author of Plumbing and House Sanitation. Other important sections are those on Statics, Strength of Materials, Mechanical Drawing and Practical Problems in Construction in Steel and Concrete.

Following the wording of the preface, the cyclopedia embraces not only the fundamentals of civil engineering, but their application to all types of modern engineering problems. It is especially designed for home study, as a means of self-help and self-instruction being, in fact, a compilation of regular instruction papers from the civil engineering course of the American School of Correspondence. The subjects are concisely and clearly handled, in simple language free from abstruse formulas, and are embellished with an unusual number of attractive illustrations. A complete system of indexes adds to the value of the cyclopedia as a work of ready reference. The volumes are printed

on high-grade paper and are very substantially bound.

Surveyor's Hand Book. By T. F. Taylor, M. Am. Soc. C. E., Professor of Civil Engineering in the University of Texas. Chicago and New York, The Myron C. Clark Publishing Co. Flexible leather, 12x7 ins.; pp. 328, illustrated; \$2 net.

To those who imbibed their instruction in surveying instruments and operations from Davies and Gillespie the wealth of tables, formulas, methods and instructions given by Prof. Taylor in his present book appears an almost sacrilegious attempt to belittle native ingenuity. So far at least as ordinary surveying operations, it is not easy to see wherein the surveyor could ask more of a handbook than he gets in this one. Surveying methods, however, unlike surveys, have no metes and bounds, and it is too much to expect that everyone will find all he wants just as he wants it in this or any other book on surveying. Setting aside his prejudice in favor of certain chosen methods and processes, however, the surveyor will not find in this book a lack of instructions for performing almost any surveying operation he is likely to need in his work. This is all that can reasonably be asked of any book of pocket size.

Prof. Taylor has divided his book into 12 chapters as follows: Chain Surveying, Compass Surveying, Transit Survey, Calculation of Areas, Division of Land, Leveling, Topographic Survey, Railroad Survey, Earthwork, City Surveying, Plotting and Lettering, Government Surveying and Trigonometric Formulas. The tables comprise logarithms of numbers, logarithmic sines, natural sines and cosines, natural tangents and cotangents and earthwork tables. It is not feasible nor does it seem necessary here to itemize the contents, more fully. The author's purpose has been to give all the essentials for ordinary surveying work of each of the classes mentioned and he has in the opinion of the reviewer succeeded remarkably well in his task.

Main Sewerage and Sewage Disposal.—By T. Aird Murray, C. E., Toronto, Ont., The Canadian Engineer. Paper, 6x9 ins.; pp. 16; illustrated; 25 cts.

This pamphlet reprinted from a series of articles contributed to the "Canadian Engineer" is a terse and well written outline of modern practice in sewerage and sewage disposal. The author divides his text into five chapters as follows: Necessity of Good Sewerage and Sewage Disposal, Points in a Main Sewerage System, Evolutions of Sewage Disposal and Remarks on Bacteriological Filtration, A Scheme for a Small City, Hints on Administration.

Portland Cement Sidewalk Construction. By C. W. Boynton, Chicago; Universal Portland Cement Co. Paper, 6x9 ins.; pp. 61; illustrated; sent free.

This little book, though printed for gratuitous distribution, deserves a place in the racks of engineering manuals. It is a well written, practical manual on cement sidewalk construction—a much better treatise than is found in most of the more pretentious books on cements and concrete. Beginning with a clear statement of the purposes of sidewalks the author takes up in succession the selection of materials, foundation construction, proportioning the mixture, forms, mixing, placing, finish and finishing, cure and protection, grades, vault work, cost of work and tools and equipment and concludes with a specification for Portland cement sidewalks. The text is excellently illustrated with line drawings of structural features and forms and with half-tone views showing faulty construction in various respects and the results which follow. There are a number of useful and instructive tables.

Rock Excavation

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M. Am. Soc. C. E. Editor "Engineering-Contracting."

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The Cost of Machine Drilling.
Cost of Diamond Drilling
Explosives.
Charging and Firing.
Methods of Blasting.
Cost of Loading and Transporting Rock.
Quarrying Stone.
Open Cut Excavation.
Methods and Costs on the Chicago Drainage Canal.
Cost of Trenches and Subways.
Subaqueous Excavation.
Cost of Railway Tunnels.
Cost of Drifting, Shaft Sinking and Stopping.

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HALBERT P. GILLETTE,

M. Am. Soc. C. E. Editor "Engineering-Contracting."

A book that should be in the hands of every man who is in charge of "moving dirt," whether with pick and shovel, plow and scraper, steam shovel and dredge, or any other tool for digging and conveying earth. The contents include:

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Earth Shrinkage.
Earth Classification.
Cost of Loosening and Shoveling.
Cost of Dumping, Spreading, Rolling.
Cost of Wheelbarrows and Carts.
Cost by Wagons.
Cost by Buck and Drag Scrapers.
Cost by Wheel Scrapers.
Cost by the Elevating Grader.
Cost by Steam Shovels.
Cost by Cars.
How to Handle a Steam Shovel Plant.
Summary and Table of Costs.
Cost of Trenching and Pipe Laying.
The Cost of Hydraulic Excavation.
Cost of Dredging.
Miscellaneous Cost Data.
Earth and Earth Structures.
Rapid Field and Office Survey Work.
Overhaul Calculation.
A Small "Home-Made" Dipper Dredge or Steam Shovel.
Detailed Description and Drawings.
Cost of Making the Dredge.
Cost of Operating.

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CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Sept. 2. Chicago, Ill.	Aug. 5
Sept. 2. York, Pa.	Aug. 26
Sept. 2. Fargo, N. Dak.	Aug. 26
Sept. 4. Brantford, Ont.	Sept. 12
Sept. 4. Harrisburg, Pa.	Sept. 12
Sept. 4. Butler, Pa.	Sept. 12
Sept. 5. Cleveland, O.	Aug. 26
Sept. 7. Beaver, Okla.	Aug. 19
Sept. 7. Valparaiso, Ind.	Aug. 19
Sept. 7. Speedwell, Va.	Aug. 26
Sept. 7. Chillicothe, O.	Aug. 26
Sept. 7. Benton Harbor, Mich.	Aug. 26
Sept. 7. Liberty, Ill.	Sept. 12
Sept. 7. Columbus, Ind.	Sept. 12
Sept. 7. Franklin, Ind.	Sept. 12
Sept. 8. Salinas, Cal.	Aug. 19
Sept. 8. Salinas, Cal.	Aug. 19
Sept. 8. Manhattan, Kan.	Aug. 26
Sept. 8. Paoli, Ind.	Aug. 26
Sept. 8. Vincennes, Ind.	Aug. 26
Sept. 8. Rensselaer, Ind.	Aug. 26
Sept. 8. Lebanon, Ind.	Sept. 12
Sept. 8. Quincy, Ill.	Sept. 12
Sept. 8. Brownstown, Ind.	Sept. 12
Sept. 9. Ithaca, N. Y.	Aug. 26
Sept. 9. Ocala, Fla.	Aug. 26
Sept. 9. Norristown, Pa.	Sept. 12
Sept. 9. South Bend, Ind.	Sept. 12
Sept. 9. Memphis, Mo.	Sept. 12
Sept. 9. Baltimore, Md.	Sept. 12
Sept. 10. Monongahela, Pa.	Aug. 26
Sept. 10. Ashland, O.	Aug. 26
Sept. 10. Goshen, Ind.	Sept. 12
Sept. 10. Wilkesbarre, Pa.	Sept. 12
Sept. 11. Norristown, Pa.	Sept. 12
Sept. 11. Allentown, Pa.	Sept. 12
Sept. 11. Reading, Pa.	Sept. 12
Sept. 12. Lancaster, O.	Sept. 12
Sept. 14. Moscow, Idaho.	Aug. 26
Sept. 14. Los Angeles, Cal.	Sept. 12
Sept. 15. Great Falls, Mont.	Sept. 12
Sept. 15. Amsterdam, N. Y.	Sept. 12
Sept. 15. Williston, N. Dak.	Sept. 12
Sept. 16. Morenci, Ariz.	Aug. 19
Sept. 16. Franklin, Pa.	Sept. 12
Sept. 21. Los Angeles, Cal.	Aug. 26
Sept. 29. Little Falls, Minn.	Aug. 26
Oct. 1. Stanford, Ky.	Sept. 12
Oct. 6. L'Original, Ont.	Sept. 12

Buildings.

Sept. 2. Cleveland, O.	Aug. 12
Sept. 2. Cleveland, O.	Aug. 12
Sept. 2. Brooklyn, N. Y.	Aug. 26
Sept. 2. Owings Mills, Md.	Aug. 26
Sept. 2. Owings Mills, Md.	Aug. 26
Sept. 3. Fort Monroe, Va.	Aug. 19
Sept. 3. Fairview, Pa.	Aug. 19
Sept. 3. St. Louis, Mo.	Aug. 19
Sept. 3. Fort Slocum, N. Y.	Aug. 26
Sept. 4. Agricultural College, Minn.	Aug. 12
Sept. 4. Pittsburg, Pa.	Aug. 26
Sept. 4. Emory, Tex.	Sept. 12
Sept. 4. Pittsburg, Pa.	Sept. 12
Sept. 5. Portsmouth, N. H.	Aug. 19
Sept. 5. Biwabik, Minn.	Sept. 12
Sept. 7. Buffalo, Okla.	Aug. 26
Sept. 7. Bloomington, Ill.	Sept. 12
Sept. 7. Youngstown, O.	Sept. 12
Sept. 8. Washington, D. C.	Aug. 19
Sept. 8. Cincinnati, O.	Aug. 26
Sept. 8. Fort Brady, Mich.	Aug. 26
Sept. 8. Pittsburg, Pa.	Sept. 12
Sept. 8. Philadelphia, Pa.	Sept. 12
Sept. 9. Sheridan, Wyo.	Aug. 12
Sept. 9. Baltimore, Md.	Sept. 12
Sept. 9. Washington, Ind.	Sept. 12
Sept. 10. Kenosha, Wis.	Aug. 12
Sept. 10. Richmond, Va.	Aug. 26
Sept. 10. Danville, Pa.	Aug. 26

Sept. 10. Fort Wood, N. Y. H.	Aug. 19
Sept. 10. Nadeau, Kan.	Aug. 19
Sept. 12. Fort Slocum, N. Y.	Aug. 19
Sept. 14. St. Louis, Mo.	Aug. 5
Sept. 14. Saybrook, O.	Sept. 12
Sept. 14. Houston, Tex.	Sept. 12
Sept. 11. Boston, Mass.	Sept. 12
Sept. 14. Agnews, Cal.	Sept. 12
Sept. 15. Rock Hill, S. C.	Aug. 26
Sept. 16. Youngstown, O.	Aug. 12
Sept. 16. Fort Leavenworth, Kan.	Sept. 12
Sept. 17. Escanaba, Mich.	Aug. 19
Sept. 17. Washington, D. C.	Aug. 19
Sept. 17. Beaverdam, O.	Aug. 26
Sept. 18. Rochester, N. Y.	Aug. 19
Sept. 19. Fort Sheridan, Ill.	Aug. 26
Sept. 19. Austin, Tex.	Sept. 12
Sept. 19. Phoenix, Ariz.	Sept. 12
Sept. 21. Little Rock, Ark.	Aug. 19
Sept. 21. Cleveland, O.	Sept. 12
Sept. 22. Greenwood, S. C.	Aug. 19
Sept. 23. Green Bay, Wis.	June 17
Sept. 23. Wheeling, W. Va.	Sept. 12
Sept. 23. Fort Hancock, N. J.	Sept. 12
Sept. 24. Baltimore, Md.	Aug. 26
Sept. 28. Dalton, Ga.	Aug. 19
Sept. 29. Bridgeton, N. J.	Aug. 26
Sept. 30. Cape Girardeau, Mo.	Aug. 5
Oct. 1. Charlottesville, Va.	Aug. 26
Oct. 5. Chippewa Falls, Wis.	Aug. 26
Oct. 5. Lebanon, Ind.	Sept. 12
Oct. 10. Butte, Mont.	Aug. 19
Oct. 19. San Juan, P. R.	Sept. 12

Roads and Streets.

Sept. 2. Jamesburg, N. J.	Aug. 19
Sept. 2. Pascagoula, Miss.	Aug. 19
Sept. 2. Long Island City, N. Y.	Aug. 26
Sept. 2. Brooklyn, N. Y.	Aug. 26
Sept. 2. Kansas City, Mo.	Aug. 26
Sept. 2. Baltimore, Md.	Aug. 26
Sept. 3. Dublin, Ga.	Aug. 19
Sept. 3. Youngstown, O.	Aug. 26
Sept. 3. New York, N. Y.	Aug. 26
Sept. 3. New York, N. Y.	Aug. 26
Sept. 3. Louisville, Ky.	Sept. 12
Sept. 3. Sacramento, Cal.	Sept. 12
Sept. 4. Cincinnati, O.	Aug. 19
Sept. 4. Lewiston, Idaho.	Aug. 26
Sept. 5. Terre Haute, Ind.	Aug. 19
Sept. 5. Fort Mackenzie, Wyo.	Aug. 19
Sept. 5. Fond Du Lac, Wis.	Aug. 26
Sept. 5. Chicago, Ill.	Sept. 12
Sept. 7. Mankato, Minn.	Aug. 19
Sept. 7. Mankato, Minn.	Aug. 26
Sept. 7. Danville, Ind.	Aug. 26
Sept. 7. Osceola, Ia.	Aug. 26
Sept. 7. Ingram, Pa.	Sept. 12
Sept. 7. Kirksville, Mo.	Sept. 12
Sept. 8. Vincennes, Ind.	Aug. 19
Sept. 8. Muskogee, Okla.	Sept. 12
Sept. 8. Bedford, N. Y.	Sept. 12
Sept. 8. Muskegon, Mich.	Sept. 12
Sept. 8. Muncie, Ind.	Sept. 12
Sept. 8. Martinsville, Ind.	Sept. 12
Sept. 8. Corydon, Ind.	Sept. 12
Sept. 9. Muncie, Ind.	Aug. 19
Sept. 9. Brooklyn, N. Y.	Sept. 12
Sept. 9. Chicago, Ill.	Sept. 12
Sept. 9. Baltimore, Md.	Sept. 12
Sept. 9. Bloomington, Ind.	Sept. 12
Sept. 10. New York, N. Y.	Sept. 12
Sept. 10. Cambridge, O.	Sept. 12
Sept. 11. Cincinnati, O.	Aug. 26
Sept. 12. Cleveland, O.	Aug. 26
Sept. 14. Decatur, Ala.	Aug. 26
Sept. 14. Edgewater, N. J.	Sept. 12
Sept. 15. Milford, Pa.	Sept. 12
Sept. 15. St. Louis, Mo.	Sept. 12
Sept. 17. Tomah, Wis.	Sept. 12

Sewers.

Sept. 2. Appleton, Wis.	Aug. 26
Sept. 3. Point Pleasant Beach, N. J.	Aug. 19
Sept. 4. North Braddock, Pa.	Aug. 26
Sept. 4. Duluth, Minn.	Sept. 12
Sept. 4. Pittsburg, Pa.	Sept. 12
Sept. 4. Dayton, O.	Sept. 12
Sept. 5. Lorain, O.	Aug. 26
Sept. 5. Milwaukee, Wis.	Sept. 12
Sept. 5. Evansville, Ind.	Sept. 12
Sept. 7. Vicksburg, Miss.	July 29
Sept. 7. Cresco, Ia.	Aug. 19
Sept. 7. Mitchell, S. D.	Aug. 19
Sept. 7. Cresco, Ia.	Aug. 26
Sept. 7. Columbus, Ind.	Sept. 12
Sept. 8. Hackensack, N. J.	Aug. 19
Sept. 8. Hudson, Wis.	Aug. 19
Sept. 8. Crookston, Minn.	Aug. 26
Sept. 8. Carroll, Ia.	Aug. 26
Sept. 8. Milwaukee, Wis.	Sept. 12
Sept. 8. Saranac Lake, N. Y.	Sept. 12
Sept. 9. Normal City, Ind.	Sept. 12
Sept. 9. Brooklyn, N. Y.	Aug. 26
Sept. 9. Oakland, Cal.	Aug. 26
Sept. 9. Brooklyn, N. Y.	Sept. 12
Sept. 9. Brooklyn, N. Y.	Sept. 12
Sept. 9. Chicago, Ill.	Sept. 12
Sept. 10. Chicago, Ill.	Sept. 12
Sept. 11. Piteairn, Pa.	Aug. 26
Sept. 14. Vicksburg, Miss.	Sept. 12
Sept. 14. Washington, D. C.	Sept. 12
Sept. 15. Peoria, Ill.	Aug. 26
Sept. 15. Upper Sandusky, O.	Sept. 12
Sept. 16. Oakland, Cal.	Sept. 12
Sept. 16. Brooklyn, N. Y.	Sept. 12

Water Supply.

Sept. 2. Cohoes, N. Y.	Sept. 12
Sept. 2. Platte, S. Dak.	Aug. 19
Sept. 2. Boston, Mass.	Aug. 26
Sept. 3. Fort Sam Houston, Tex.	Aug. 19
Sept. 3. Philadelphia, Pa.	Aug. 26
Sept. 3. New York, N. Y.	Aug. 26
Sept. 4. Fort McPherson, Ga.	Aug. 12
Sept. 4. Garfield, N. J.	Sept. 12
Sept. 4. Manchester, Miss.	Sept. 12
Sept. 5. Milwaukee, Wis.	Sept. 12
Sept. 5. Wellsville, O.	Sept. 12
Sept. 7. University, Ala.	Aug. 26
Sept. 7. Sturgeon Bay, Wis.	Sept. 12
Sept. 7. Mitchell, S. Dak.	Sept. 12
Sept. 7. Chambersburg, Pa.	Sept. 12
Sept. 8. Holyrood, Kan.	Aug. 26
Sept. 9. Springfield, Mass.	Aug. 19
Sept. 9. Chicago, Ill.	Sept. 12
Sept. 10. Pleasantville, Pa.	Sept. 12
Sept. 10. Hopewell, N. J.	Sept. 12
Sept. 10. Geddes, S. Dak.	Sept. 12
Sept. 10. Stamford, Conn.	Sept. 12
Sept. 11. Franklin, Pa.	Sept. 12
Sept. 11. New Haven, Mo.	Sept. 12
Sept. 15. Gulfport, Miss.	Sept. 12
Sept. 16. Morenci, Ariz.	Aug. 19
Sept. 16. Oxford, O.	Aug. 26
Sept. 21. Aberdeen, S. Dak.	Aug. 26
Sept. 22. Reading, Pa.	Aug. 26
Sept. 24. Evansville, Ind.	Aug. 12
Oct. 5. Harrisonburg, Ia.	Aug. 26

Miscellaneous.

Sept. 3. Philadelphia, Pa.	Bulkhead, Aug. 26
Sept. 3. New York, N. Y.	Repairing Fences, Aug. 26
Sept. 3. Pittsburg, Pa.	Tunnel, Sept. 2
Sept. 7. Memphis, Tenn.	Barges, Sept. 2
Sept. 8. Kenosha, Wis.	Street Lighting, Aug. 5
Sept. 8. Pittsburg, Pa.	Resetting Bollers, Etc., Sept. 2
Sept. 8. Niagara Falls, Ont.	Rifle Range, Sept. 2
Sept. 9. Cincinnati, O.	Tow Boat, Sept. 2
Sept. 9. New York, N. Y.	Damproofing, Sept. 2
Sept. 10. Cincinnati, O.	Dam, Aug. 19
Sept. 10. Wilmington, Del.	Erecting Metal Work, Aug. 19
Sept. 10. Mansfield, O.	Power House, Aug. 26
Sept. 10. Wilmington, Del.	Light House Foundation, Sept. 2
Sept. 14. Winnipeg, Man.	Lock Gates, Aug. 26
Sept. 14. Fort Sumter, S. C.	Wharf, Sept. 2
Sept. 14. Agnews, Cal.	Power Plant, Sept. 2
Sept. 15. Winnipeg, Man.	Electric Plant, Aug. 5
Sept. 16. Philadelphia, Pa.	Coaling Station, Masonry, Etc., Aug. 26
Sept. 16. Oakland, Cal.	Riprap Wall, Sept. 2
Sept. 19. Tacoma, Wash.	Electric Plant, Aug. 19
Sept. 19. Nenia, O.	Power Plant, Etc., Sept. 2
Nov. 2. Washington, D. C.	Submarines, Aug. 5

Excavation, Earth and Rock.

Sept. 2. Brooklyn, N. Y.	Grading Lot, Aug. 26
Sept. 5. Philadelphia, Pa.	Dredging, Aug. 12
Sept. 5. Woodstock, Ill.	Ditch Work, Aug. 26
Sept. 5. Annawan, Ill.	Ditch Work, Aug. 26
Sept. 5. Houston, Tex.	Drainage Work, Sept. 2
Sept. 7. Greenville, Miss.	Levee Work, Aug. 12
Sept. 8. New Orleans, La.	Dredging, Sept. 2
Sept. 9. Brooklyn, N. Y.	Dredging, Aug. 26
Sept. 9. Albany, N. Y.	Barge Canal Work, Aug. 26
Sept. 10. Brooklyn, N. Y.	Grading Park, Sept. 2
Sept. 12. Morrison, Ill.	Drainage Work, Sept. 2
Sept. 14. Boston, Mass.	Dredging, Aug. 12
Sept. 14. Norfolk, Va.	Dredging, Aug. 26
Sept. 14. New York, N. Y.	Dredging, Aug. 26
Sept. 16. Brooklyn, N. Y.	Dredging, Sept. 2
Sept. 18. Utica, Neb.	Ditch Work, Aug. 26

Materials, Machines, Supplies, Tools, Etc.

Sept. 2. Baltimore, Md., Pump Slip Indicator, Aug. 26
 Sept. 3. Bellevue, Pa., Hose, Wagons, Etc., Aug. 26
 Sept. 3. New York, N. Y., Cement, Sand, Aug. 26
 Sept. 3. New York, N. Y., Pipe, Street Washers, Aug. 26
 Sept. 3. New York, N. Y., Gravel, Aug. 26
 Sept. 4. Jacksonville, Fla., Stokers, Aug. 19
 Sept. 5. Charleston, S. C., Lumber, Rubble Stone, Aug. 12
 Sept. 5. Bremerton, Wash., Electric Elevator, Aug. 19
 Sept. 8. Muskegon, Mich., Pump, Aug. 19
 Sept. 8. Vicksburg, Miss., Portland Cement, Aug. 19
 Sept. 8. Harrisburg, Pa., Vacuum System, Sept. 2
 Sept. 8. New York, N. Y., Timber, Etc., Sept. 2
 Sept. 9. Baltimore, Md., Boat Repairs, Sept. 2
 Sept. 9. Atlanta, Ga., Motor, Sept. 2
 Sept. 9. Washington, D. C., Lumber, Sept. 2
 Sept. 9. Washington, D. C., Piles, Sept. 2
 Sept. 10. Memphis, Tenn., Sewage Pump, Aug. 19
 Sept. 10. Columbus Barracks, O., Electric Elevator, Sept. 2
 Sept. 10. White Plains, N. Y., Electrical Equipment, Etc., Sept. 2
 Sept. 11. Kansas City, Mo., Boilers, Etc., Sept. 2
 Sept. 14. Washington, D. C., Engines, Aug. 19
 Sept. 14. Cumberland, Wls., Generators, Etc., Sept. 2
 Sept. 22. Cincinnati, O., Machine Tools, Sept. 2
 Sept. 22. Athens, O., Boilers, Sept. 2
 Sept. 23. Raleigh, N. C., Electric Elevator, Sept. 2
 Sept. 24. Chicago, Ill., Power Plant Equipment, Aug. 26
 Oct. 14. Vancouver, B. C., Pipe, Aug. 19

BIDS ASKED**Bridges.**

Bids are asked on following work, the notes being arranged alphabetically by states:

Los Angeles, Cal.—Until Sept. 14, by Board Public Works, for constructing reinforced concrete bridge over Los Angeles River at Main St., the work including 600 cu. yds., Class A concrete; 1,822 cu. yds., Class B concrete; 3,852 cu. yds., Class C concrete; 540 tons of riprap; 614 foundation piles, etc.

Liberty, Ill.—Until 2 p. m., Sept. 7, by Town Clerk, for repairing Buskirk bridge over McKee Creek.

Quincy, Ill.—Until 9 a. m., Sept. 8, by Highway Commissioners of Ellington Township, L. H. Knorr, Chairman, for repairing and strengthening iron bridge known as Pfanschmidt bridge. Specifications with County Attorney, at Quincy.

Brownstown, Ind.—Until 11 p. m., Sept. 8, by H. W. Wacker, County Auditor, for repair of the Ewing bridge across White River in Brownstown Township, and the Rockford bridge across White River, Redding Township.

Franklin, Ind.—Until 10 a. m., Sept. 7, by W. B. Jennings, County Auditor, for constructing two steel bridges; one 36 ft. long, the other 12 ft. long.

Goshen, Ind.—Until 9:30 a. m., Sept. 10, by D. O. Batchelor, County Auditor, for constructing two reinforced concrete bridges, 16 ft. and 14 ft. spans; also for constructing two small iron bridges and for repaving three bridges by new stringers and floors.

Lebanon, Ind.—Until Sept. 8, by B. F. Herdlich, County Auditor, for repair of 120 ft. stone arch over Sugar Creek in Clinton Township.

South Bend, Ind.—Until 11 a. m., Sept. 9, by John W. Harbon, County Auditor, for repairing Orphans' Home bridge.

Stanford, Ky.—Until Oct. 1, by G. B. Cooper, Clerk, County Fiscal Court, for iron or steel bridge, two spans, each 32 ft. long and 16 ft. wide, to be erected over Hanging Fork Creek on the Stanford and Hustonville Pike.

Baltimore, Md.—Until 11 a. m., Sept. 9, by B. T. Fendall, City Engineer, for furnishing the 15 in. track springers and connections and erecting them in place on the Guilford Ave. bridge over Jones Falls.

Columbus, Miss.—Until Sept. 7, by County

Supervisor, D. D. Richards, Clerk, for constructing two concrete bridges.

Memphis, Mo.—C. C. Critz, County Highway Engineer, will let contracts for following bridges at bridge site at 2 p. m. of respective dates: Sept. 9, Beaver bridge, Union Township, 36 ft. span, combination; Sept. 10, Lockheart bridge, Johnson Township, 20 ft. trestle; Sept. 11, Blaine bridge, Mt. Pleasant Township, 22 ft. trestle.

Great Falls, Mont.—Until 11 a. m., Sept. 15, by David M. Wood, County Clerk, for constructing three steel highway bridges.

Williston, N. Dak.—Until 10 a. m., Sept. 15, by E. M. Atterberry, County Auditor, for constructing either a steel bridge with reinforced concrete abutment and concrete floor, or an all reinforced concrete bridge over Long Creek. Bridge is to be 40 ft. long, 16 ft. roadway and 10 ft. above water line. Plans and specifications are to be furnished by bidders.

Amsterdam, N. Y.—Until Sept. 15, by W. Barlow Dunlap, Amsterdam, for the construction of a 2-span steel bridge across the Schoharie Creek between the towns of Florida and Glen. Bids are to include all labor and materials necessary for making surveys, borings and designs for the abutments, pier and approaches and the construction of the pier and abutments and the erection thereon of a 2-span steel bridge according to the specifications of the New York State Engineer's Department for steel highway bridge superstructures. The bridge is about 465 ft. long.

Lancaster, O.—Until Sept. 12, by County Commissioners, for superstructure of bridge over Hocking River in Berne Township, and for superstructure of bridge over Walnut Creek in Walnut Township.

Allentown, Pa.—Until 10 a. m., Sept. 11, by County Commissioners, J. S. Troxell, Clerk, for repairing and for alterations to a combination highway and trolley bridge over Lehigh Valley R. R., at Hokendaqua.

Butler, Pa.—Until noon, Sept. 4, by County Commissioners, for constructing steel bridge in Cherry Township.

Franklin, Pa.—Until 1 p. m., Sept. 16, by County Commissioners, E. K. Smiley, Clerk, for constructing steel or wooden bridge.

Harrisburg, Pa.—Until 11 a. m., Sept. 4, by County Commissioners, John S. Longenecker, Chairman, for rebuilding steel highway bridge over Spring Creek at Hershey, Pa. Certified check for \$200 required with bid.

Norristown, Pa.—Until noon, Sept. 9, by County Commissioners, Robert C. Miller, Clerk, for constructing bridge over Manatawny Creek in the borough of Pottstown. John H. Dager, Engineer.

Norristown, Pa.—Until 11 a. m., Sept. 11, by County Commissioners, for constructing steel girder bridge.

Reading, Pa.—Until 10 a. m., Sept. 11, by County Controller, for constructing reinforced concrete bridge at Trap Rock over Hay Creek in Robeson Township.

Wilkesbarre, Pa.—Until 2 p. m., Sept. 10, by J. M. Norris, County Controller, for constructing two steel girder bridges. Harry Myers, Engineer.

Brantford, Ont.—Until noon, Sept. 4, by Samuel Suddaby, care City Clerk, for the construction of a bridge across the Canal at the foot of Alfred St., work consisting of concrete abutments and wing walls, and steel bridge, 60 ft. span, 18 ft. roadway and 6 ft. sidewalk. Alternate bids will be received for a reinforced concrete arch. T. Harry Jones, City Engineer.

L'Original, Ont.—Until noon, Oct. 6, by E. Abbott Johnson, County Clerk, for construction of iron highway bridge, 115 ft. span, over Big Castor River. Bids are also asked for concrete or stone masonry work required for the bridge.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Phoenix, Ariz.—Until noon, Sept. 19, by James J. Riggs, Secretary Board of Control, for labor and materials for construction of an asylum for the insane near Phoenix; \$45,000 is available for the work. Thornton Fitzhugh, Architect.

Agnews, Cal.—Until 4:30 p. m., Sept. 14, by W. S. Sonthelmer, Secretary Board of Managers, San Jose, Cal., for the construction and erection of two buildings (duplicates), at Agnews State Hospital, for disturbed and violent patients; also for erection of Superintendent's residence at same hospital. Sellon & Hemmings, State Architects, Room 804, 244 Kearny St., San Francisco, Cal.

Bloomington, Ill.—Until Sept. 7, by G. H. Miller, for reconstruction of third story of the McLean County Jail.

Lebanon, Ind.—Until Oct. 5, by B. F. Herdlich, County Auditor, for remodeling County Jail.

Washington, Ind.—Until Sept. 9, by Thomas Nugent, County Auditor, for remodeling County Court House.

Fort Leavenworth, Kan.—Until 11 a. m., Sept. 16, by Capt. Wm. D. Davis, Constructing Q. M., for the construction of an isolation hospital, including plumbing, hot water heating, electric wiring and electric lighting fixtures, at Fort Leavenworth. Official advertisement will be found elsewhere in this issue.

Boston, Mass.—Until 11 a. m., Sept. 14, by Quartermaster, U. S. Marine Corps, Washington, D. C., for completion of Marine barracks at Boston.

Baltimore, Md.—Until 11 a. m., Sept. 9, by Edward D. Preston, Inspector of Buildings, City Hall, for erection of a building at Reisterstown Road and 5th Ave., to be used as a school house.

Blwabik, Minn.—Until Sept. 5, by City Clerk, for erection of a city hall.

Fort Hancock, N. J.—Until 2 p. m., Sept. 23, by Capt. M. N. Falls, Constructing Q. M., for construction, plumbing, heating and electric wiring of one double set of N. C. O. quarters and two double sets of Firemen's quarters at Fort Hancock.

Cleveland, O.—Until noon, Sept. 21, by Chas. Orr, Director of Schools, E. 6th St., for plumbing, gas-fitting and sewers for school building on Columbia Ave., N. E.

Saybrook, O.—Until 6 p. m., Sept. 14, by W. J. Richmond, Clerk Board of Education, for erection of a school house in Sub-District No. 2.

Youngstown, O.—Until noon, Sept. 7, by W. N. Ashbaugh, Clerk Board of Education, 29 W. Federal St., for installation of fire escapes on the several school buildings in the city.

Philadelphia, Pa.—Until 10:30 a. m., Sept. 8, by Board of Education, William Dick, Secretary, for constructing new school building, to cost about \$500,000.

Pittsburg, Pa.—Until 10:30 a. m., Sept. 4, by Department of Public Safety, Edward G. Lang, Director, for erection of engine house at Chartiers and Church Aves., and an engine house at Alleghenya, Wallace and Nutter Sts., Gazzam's Hill.

Pittsburg, Pa.—Until 10 a. m., Sept. 8, by Department of Charities and Corrections, James P. Shaw, Director, for construction of dry rooms and installing fireproof partitions at Pittsburg City Home and Hospital. Plans, etc., with John P. Brannan, Assistant Superintendent Bureau of Building Inspection, 6th Ave. and Cherry Alley.

Austin, Tex.—Until Sept. 19, by Water, Light and Power Commissioners for the construction of a concrete steel addition to the municipal pumping station, approximately \$9 x 64 x 35 ft. For specifications, blank forms and other information, address Walter G. Kirkpatrick, Engineer, Jackson, Miss., or The Water, Light and Power Commissioners, Austin, Tex.

Emory, Tex.—Until Sept. 4, by County Commissioners, for constructing 2-story court house.

Houston, Tex.—Until Sept. 14, by Mayor H. B. Rice, for erection of a 2-story 8-room school building.

Wheeling, W. Va.—Until 11 a. m., Sept. 23, by Capt. F. W. Altstaetter, U. S. Engrs., for building lockkeepers' houses at Dams Nos. 18 and 26, Ohio River.

San Juan, Porto Rico.—Until 3 p. m., Oct. 19, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction complete (except elevators) for the U. S. Post Office and Court House at San Juan.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Sacramento, Cal.—Until 11 a. m., Sept. 3, by County Supervisors, Wm. B. Hamilton, Clerk, for the construction of a macadam roadway with graded berms and concrete culverts, along the Sacramento to Folsom road, a distance of 17 miles. The upper courses of the macadam strip 16 ft. in width, and for 2 ft. each side thereof, to be oiled with heavy asphaltic oil.

Chicago, Ill.—Until 11 a. m., Sept. 5, by Department Public Works, Room 705, 200 Randolph St., for grading and paving with macadam pavement 91st St., from Hoyne Ave. to Western Ave., and Western Ave. from 91st St. to 95th St.

Chicago, Ill.—Until 11 a. m., Sept. 9, by Board Local Improvements, Charles A. V. Standish, Secretary, for paving work, as follows: Four contracts for paving with vitrified brick, seven contracts for paving with

asphalt, one contract for paving with lime-stone and two contracts for paving with blast furnace slag.

Bloomington, Ind.—Until 2 p. m., Sept. 9, by S. M. Kerr, County Auditor, for constructing macadam road in Van Buren Township.

Corydon, Ind.—Until 2 p. m., Sept. 8, by Frank E. Watson, County Auditor, for constructing gravel or macadam road.

Martinsville, Ind.—Until 2 p. m., Sept. 8, by B. E. Thornburg, County Auditor, for constructing 2 miles of gravel road in Brown and Lewis Townships, and 1½ miles of gravel road in Brown Township.

Muncie, Ind.—Until Sept. 8, by John A. Jackson, City Clerk, for resurfacing with brick portions of several streets.

Louisville, Ky.—Until Sept. 3, by Board Public Works for constructing new granitoid sidewalks to cost about \$12,000.

Baltimore, Md.—Until 11 a. m., Sept. 9, by Commissioners for Opening Streets, Eugene F. Rodgers, Clerk, Hcen Bldg., for grading curbing, guttering and paving with tarred macadam or macadam portions of Granada Ave. and Springdale Ave.

Muskegon, Mich.—Until noon, Sept. 8, by B. H. Tellman, City Recorder, for paving portions of First St. and Miller Ave., with bituminous macadam waterproof pavement and combination curb and gutter 2½ ft. wide on each side of streets.

Kirksville, Mo.—Until 8 p. m., Sept. 7, by J. C. Carothers, City Clerk, for constructing 16,000 sq. yds. vitrified brick pavement and 6,400 lin. ft. concrete curb. Official advertisement will be found elsewhere in this issue.

St. Louis, Mo.—Until Sept. 15, by Board Public Improvements, for paving about 6½ miles of streets. Estimated cost is \$315,000, and portions of seven streets will be paved with asphalt, three streets with brick, one street with bitulithite, one street with granite and two streets with telford.

Edgewater, N. J.—Until 8 p. m., Sept. 14, by Clarence E. Booth, Borough Clerk, for grading, macadamizing and guttering 12,850 ft. of road. Watson G. Clark, Borough Engineer, Tenafly, N. J.

Bedford, N. Y.—Until 4 p. m., Sept. 8, by Joseph E. Merriam, Town Clerk, Mt. Kisco, N. Y., for macadamizing, grading, etc., 8 miles of road. Byrne & Darling, Engineers, White Plains, N. Y.

Brooklyn, N. Y.—Until 11 a. m., Sept. 9, by Bird S. Coler, Borough President, for the work under five contracts for paving. Largest contract calls for regulating and repaving with asphalt pavement on a concrete foundation the roadway of Prospect Pl., the work including 6,120 sq. yds. of asphalt pavement, including binder course, 850 cu. yds. concrete, 410 lin. ft. new curbstone, furnished and set in concrete, etc.

New York, N. Y.—Until 3 p. m., Sept. 10, by the Park Board, Arsenal Bldg., 5th Ave. and 64th St., for labor and materials for constructing and laying hexagonal asphalt block walks from Bartow station to the City Island Bridge, in Pelham Bay Park, and from the junction of Jerome Ave. and Moshulu Parkway to the Van Cortlandt Station, in Van Cortlandt Park, in the city of New York. Security required is \$5,000.

Cambridge, O.—Until noon, Sept. 10, for grading, drainage, curbing and paving of several streets, the work including 16,000 cu. yds. excavation; 28,296 sq. yds. brick paving; 16,600 lin. ft. straight curb; 2,560 lin. ft. 15-in. pipe sewer, etc. O. M. Hoge, City Engineer. Separate bids will also be received for furnishing the brick. Official advertisement will be found elsewhere in this issue.

Muskogee, Okla.—Until Sept. 8, by L. B. Kinsey, City Engineer, for constructing 50,000 sq. yds. of bituminous concrete pavement.

Ingram, Pa.—Until 5 p. m., Sept. 7, by D. H. Hainer, Borough Clerk, for grading, curbing and paving on Ingram Ave.

Milford, Pa.—Until Sept. 15, by State Highway Department, Harrisburg, Pa., for constructing following roads in Pike County: Lehman Township, 7,700 ft.; Green Township, 18,675 ft.

Tomah, Wis.—Until 2 p. m., Sept. 17, by D. J. Aller, City Clerk, for constructing brick pavement.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Agnews, Cal.—See under Bids Asked Miscellaneous.

Oakland, Cal.—Until 10 a. m., Sept. 16, by Board Public Works, Walter E. Fawcett, Secretary, for labor and materials for constructing vitrified pipe sewer in Fallon St.,

65th St. and Oak St. Bond for \$3,000 required of successful bidder.

Washington, D. C.—Until noon, Sept. 14, by District Commissioners, for constructing Sect. 3 of East Side Intercepting sewer, boundary to Brookland. Plans, etc., with Chief Clerk, Engineers Department, 427 District Bldg.

Chicago, Ill.—Until 11 a. m., Sept. 9, by Board Local Improvements, Charles A. V. Standish, Secretary, for 12 contracts for constructing drains.

Chicago, Ill.—Until 11 a. m., Sept. 10, by Board Local Improvements, Charles A. V. Standish, Secretary, for constructing brick sewer, concrete bulkhead, concrete inverted siphon, etc., in South Kedzie Ave.

Columbus, Ind.—Until 7:30 p. m., Sept. 7, by L. F. Orr, City Clerk, for constructing lateral sewer.

Evansville, Ind.—Until 10 a. m., Sept. 5, by Board Public Works, W. F. Wunderlich, Clerk, for constructing six local sewers 10 in. and 12 in. pipe.

Normal City (P. O. Muncie), Ind.—Until Sept. 8, by J. G. Mendenhall, City Clerk, for constructing sewer in McKinley Ave.

Duluth, Minn.—Until 10 a. m., Sept. 4, by Board Public Works, R. Muchison, Clerk, for constructing sanitary sewer in W. 4th St.

Vicksburg, Miss.—The date for opening the bids for the construction of a system of house sewers has been postponed from Sept. 7 to Sept. 14, 1908. The work comprises about 30 miles of 27-in. to 8-in. pipe sewers, with the necessary manholes, flushtanks, etc. For specifications, blank forms and other information, address Walter G. Kirkpatrick, Engineer, Jackson, Miss.

Brooklyn, N. Y.—Until 11 a. m., Sept. 9, by Bird S. Coler, Borough President, for labor and material required for constructing sewers in Scott Ave., from Newtown Creek, north of Metropolitan Ave., to St. Nicholas Ave., etc., Sec. 2. Estimated cost of work is \$278,727 and it includes 1,409 lin. ft. of 186 in. sewer and 960 lin. ft. of 180 in. sewer 57,000 lin. ft. of bearing piles, and an outlet chamber, etc.

Brooklyn, N. Y.—Until 11 a. m., Sept. 9, by Bird S. Coler, Borough President, for constructing sewer in Prospect Pl. estimated to cost \$1,018, and reconstructing sewer in Stewart St., estimated to cost \$1,865.

Brooklyn, N. Y.—Until 11 a. m., Sept. 16, by Bird S. Coler, Borough President, for constructing sewer in E. 98th St., Sec. 1, estimated to cost \$60,077, a sewer in E. 98th St., Sec. 2, estimated to cost \$95,090, and a sewer in 85th St., estimated to cost \$5,039.

Saranac Lake, N. Y.—Until 1:30 p. m., Sept. 8, by Seaver A. Miller, Village Clerk, for constructing about two miles of 6 in. to 10 in. sewers. John S. Collins, Engineer, 444 Broadway, Albany, N. Y.

Dayton, O.—Until noon, Sept. 4, by W. A. Budroe, Clerk Board Public Service, for cleaning about three miles of storm water sewers.

Upper Sandusky, O.—Until noon, Sept. 15, by A. H. Stutz, Village Clerk, for constructing about 5,275 ft. combined sanitary and storm sewers, 20 to 48 ins. in diameter; 30 in. sewers and under to be of vitrified pipe, others to be of reinforced concrete, brick or vitrified pipe. The Riggs & Sherman Co., Engineers, Toledo, O.

Pittsburg, Pa.—Until 10:30 a. m., Sept. 4, by Department Public Safety, Edward G. Lang, Director, for constructing sewer for Patrol Station No. 4.

Milwaukee, Wis.—Until 10:30 a. m., Sept. 5, by Board Public Works, Charles J. Poetsch, Chairman, for constructing Sec. 1, of concrete sewer in Chicago Ave. and Montana St. Certified check for \$1,800 required with bid.

Milwaukee, Wis.—Until 10:30 a. m., Sept. 8, by Board Public Works, Charles J. Poetsch, Chairman, for constructing and laying house drains and water service connections in portions of 38th St. and 40th St.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Stamford, Conn.—Until 2 p. m., Sept. 10, by Stamford Water Co., 125 Atlantic St., for constructing a dam, together with other works necessary for the enlargement of the reservoir of the company. The work includes about 48,000 cu. yds. of earthwork; 1,350 cu. yds. of rock excavation; 14,000 cu. yds. of concrete; 1,200 cu. yds. of rubble masonry; 1,800 sq. yds. of riprap paving; 12,000 lin. ft. of wire fencing; 3,000 lin. ft. of timber railing; 250 lin. ft. of iron railing, and 200 lin. ft. of vitrified pipe culvert. A. B. Hill, Engineer, 100 Crown St. New Haven, Conn.

Chicago, Ill.—Until 11 a. m., Sept. 9, by Board Local Improvements, Charles A. V. Standish, Secretary, for 11 contracts for constructing water supply pipes.

Manchester, Mass.—Until Sept. 4, by Water Commissioners, F. J. Merrill, Chairman, for erecting a steel standpipe, 60-ft. diameter and 79 ft. high Raymond C. Allen, Manchester, is Engineer.

Gulfpport, Miss.—Until 8 p. m., Sept. 15, by Mayor J. W. Thomas, for construction of a reinforced concrete reservoir. M. F. Sullivan, City Engineer. Official advertisement will be found elsewhere in this issue.

New Haven, Mo.—Until Sept. 14, by City Clerk, for furnishing and installing water works system for the city, including 4 in., 6 in. and 8 in. pipe line, hydrants, valves, concrete reservoir, air compressor, air lift pump, boiler, and deep well drilling. Plans, etc., with Edward Hebbeler, New Haven, and at office of the Engineer W. A. Fuller, Chemical Bldg., St. Louis, Mo.

Garfield, N. J.—Until 8 p. m., Sept. 4, by Geo. H. Wright, Borough Clerk, for extending water distribution system and erecting steel stand pipe.

Hopewell, N. J.—Until 8 p. m., Sept. 10, by E. V. Savage, Borough Clerk, for constructing reservoir and pipe line. C. A. Haque, Consulting Engineer, 52 Broadway, New York.

Cohoes, N. Y.—Board of Water Commissioners, A. T. Kniffin, Superintendent, desire bids, accompanied by detailed plans and specifications for constructing a mechanical filtering plant. General specifications and information may be obtained from the Water Commissioners.

Wellsville, O.—Until noon, Sept. 5, by Board Public Service, for constructing new steel water supply cribs and pipe connections. Chas. C. Ewing, Superintendent of Water Works.

Chambersburg, Pa.—Until 6 p. m., Sept. 7, by E. V. Frey, Clerk of Council, for labor and materials for construction of concrete dam and sidewalks and supplying and building therein of wrought iron headgate, at Siloam Pumping Station. Official advertisement will be found elsewhere in this issue.

Franklin, Pa.—Until 1 p. m., Sept. 11, by County Commissioners, E. K. Smiley, Clerk, for constructing reinforced concrete reservoir.

Pleasantville, Pa.—Until 4 p. m., Sept. 10, by R. M. Davidson, Chairman, for digging (average cut 4 ft.), leading joints and backfilling about 4,000 ft., 2 in. galvanized iron pipe, 10,000 ft., 4 in. cast iron pipe, and 2,500 ft. 6 in. cast iron pipe for the borough.

Geddes, S. Dak.—Until 8 p. m., Sept. 10, by L. L. Davis, City Auditor, for construction of 22x22 ft. wooden tank on 80 ft. steel tower.

Mitchell, S. Dak.—Until Sept. 7, by City Clerk, for constructing 4 in. water main.

Cumberland, Wis.—See under Bids Asked—Materials, Machines, Supplies, Tools, etc.

Milwaukee, Wis.—Until 10 a. m., Sept. 5, by Park Commissioners, Frank P. Schumacher, Secretary, for laying water pipe from main to center plots and in center plots of 22d or Washington Ave., from National Ave. to Lincoln Ave.

Sturgeon Bay, Wis.—Until 8 p. m., Sept. 7, by H. C. Leonhardt, City Clerk, for furnishing material and installing a system of heating conduits; also a system of water mains in the streets and alleys of Sturgeon Bay. Bids will be received upon the material f. o. b. cars Sturgeon Bay and for the installation of same separately, and also upon the work as a whole. T. Maltby, Engineer, 803 Great Northern Bldg., Chicago, Ill.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Morrison, Ill.—Drainage Work.—Until 2 p. m., Sept. 12, by Commissioners Enterprise Drainage District at office of McCalmont & Ramsay, for constructing ditches requiring removal of 111,000 cu. yds. of material. John D. Arey, Engineer, Sterling, Ill.

New Orleans, La.—Dredging.—Until 11 a. m., Sept. 8, by Lieut. W. Willing, U. S. Engrs., for dredging about 900,000 cu. yds., in two jobs, between Vermillion Bay and Mermentau River, La., in connection with construction of Intercoastal canal in Louisiana. The canal is to be about 9½ miles long; 70 ft. wide at top, 5 ft. deep at mean low-water level.

Brooklyn, N. Y.—Dredging.—Until 11 a. m., Sept. 16, by Bird S. Coler, Borough President, for dredging about 9,000 cu. yds. scow measurement from Gowanus Canal.

Brooklyn, N. Y.—Grading Park.—Until 3 p. m., Sept. 10, by Park Board, Arsenal Bldg., 5th Ave. and 64th St., for labor and materials necessary to grade Greenpoint

Park, Borough of Brooklyn, together with all the work incidental thereto. Security required is \$9,000.

Houston, Tex.—Drainage Work. Until 2 p. m., Sept. 3, by South End Land Co., Houston, Tex., for the construction of about seven miles lateral ditch, with bottom width of 4 ft. and 1½ miles of main ditch with bottom width of from 1 ft. to 1½ ft., all ditches ranging from 5 to 7 ft. deep, the total work being approximately 150,000 cu. yds. of excavation. Specifications, etc., with E. L. Dormant, C. E., Klum Bldg., Houston, Tex., or Harman Engineering Co., Peoria, Ill.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Agnews, Cal.—Power Plant, Etc. Until 4:30 p. m., Sept. 14, by W. M. Southemer, Secretary Board of Managers, 7 West Santa Clara St., San Jose, Cal., for furnishing and erecting a complete power plant, conduit and sewer systems at Agnews State Hospital, Plans, etc., at Agnews, at San Jose, with Seaton & Hemmings, State Architects, 241 Kearny St., San Francisco, and with State Engineering Department, Capitol, Sacramento.

Oakland, Cal.—Riprap Wall. Until 10 a. m., Sept. 16, by Board Public Works, Walter B. Pawcett, Secretary, for construction of riprap wall along channel between 8th St. bridge and 12th St. Bond for \$7,500 required of successful bidder.

Wilmington, Del.—Light House Foundation. Until 11 a. m., Sept. 10, by the Light House Engineer, Wilmington, Del., for erecting the foundation for the light house at Miah Mam Shoal Light Station, Delaware Bay, N. J.

New York, N. Y.—Dampproofing. Until 3 p. m., Sept. 9, by Contract Clerk, Trustees Bellevue and Allied Hospitals, 419 E. 26th St., for labor and materials required for the tearing down and removal, excavation, masonry, dampproofing, repairing and replacing of machinery and all other work required to render sound and perfect the dampproofing of elevator pits, and damaged elevator machinery at Fordham Hospital, Crotona Ave. and the Southern Boulevard, New York. Surety required is \$2,000.

Cincinnati, O.—Tow Boat. Until 2 p. m., Sept. 9, by Lt.-Col. J. G. Warren, U. S. Engrs., for building wooden hull towboat with snagging appliances.

Xenia, O.—Power Plant, Etc.—Until noon, Sept. 19, by Trustees Ohio Soldiers' and Sailors' Orphans' Home, Col. John C. Roland, Secretary, for materials and labor for building new power plant and remodeling present system of light and water at Ohio Soldiers' and Sailors' Orphans' Home. Bids will be received at the same time for the purchase of the old mechanical equipment. Plans, etc., at office of J. L. Smith, Superintendent, Xenia, and with Frank L. Packard, Architect, Columbus, O.

Pittsburg, Pa.—Resetting Boiler, Etc. Until 10 a. m., Sept. 8, by Department of Charities and Corrections, James P. Shaw, Director, for resetting a boiler and rebuilding a foundation at the Municipal Hospital, Bedford Ave. and Francis St.

Pittsburg, Pa.—Tunnel. Until 10:30 a. m., Sept. 3, by Department Charities and Corrections, James P. Shaw, Director, 511 4th Ave., for building reinforced concrete steel pipe tunnel at the city farm at Marshalsea, the work including 20 lin. ft. reinforced tunnel, Type A; 600 lin. ft. reinforced tunnel, Type B; 450 lin. ft. reinforced tunnel, Type C, and 110,000 lbs. of steel reinforcement.

Fort Sumter (P. O. Moultrieville), S. C.—Wharf. Until noon Sept. 14, by Jos. T. Davidson, Constructing Q. M., for constructing wooden wharf and approach at this post.

Memphis, Tenn.—Barges. Until noon, Sept. 7, by Capt. Wm. H. Connor, U. S. Engrs., for furnishing three creosoted wooden barges.

Sturgeon Bay, Wis.—Heating Conduits. See under Bids Asked—Water Supply.

Niagara Falls, Ont.—Rifle Range. Until noon, Sept. 8, by E. F. Jarvis Secretary Department of Militia and Defence, Ottawa, Ont., for construction of a rifle range at Niagara-on-the-Lake.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Piles—Until noon, Sept. 9, by Maj. Spencer Cosby, U. S. Engrs., for furnishing and delivering piles on Pamunkey River, Va.

Washington, D. C.—Lumber. Until noon, Sept. 9, by Maj. Spencer Cosby, U. S. Engrs.,

for furnishing and delivering lumber on York River, Va.

Atlanta, Ga.—Motor.—Until 10 a. m., Sept. 9, by R. V. Lu Dow, Superintendent of Prisons and Prisoners, Washington, D. C., for furnishing and delivering at the U. S. Penitentiary, Atlanta, one 25-H.P. electric motor and material.

Baltimore, Md.—Boat Repairs.—Until 11 a. m., Sept. 9, by O. E. Lackey, Harbor Engineer, for labor and materials for repairs to ice boats "Annapolis" and "F. C. La Trobe."

Kansas City, Mo.—Boilers, Etc. Until 2 p. m., Sept. 11, by Board Public Works, Robert W. Goodnow, Secretary, for installation of boilers and sundry heating apparatus at the City Workhouse.

Raleigh, N. C.—Electric Elevator.—Until 3 p. m., Sept. 23, by James Knox Taylor, Supervising Architect, Washington, D. C., for an electric passenger elevator in the U. S. Post Office and Court House at Raleigh.

New York, N. Y.—Timber, Etc.—Until 9:15 a. m., Sept. 8, by Chief Clerk Board of Health, 55th St., and 6th Ave., for furnishing and delivering timber, lumber, molding, etc., to the Tuberculosis Sanatorium at Otisville, Orange County, New York, during the year 1908.

White Plains, N. Y.—Electrical Equipment, Etc.—Until 2 p. m., Sept. 10, by County Supervisors, Chauncy T. Secor, Chairman Building Committee, for electrical equipment and engines and dynamos, also for carpets and rugs to be used in the Supreme Court Building and Hall of Records now under construction. Lord & Hewlett, Architects, 345 Fifth Ave., New York.

Athens, O.—Boilers.—Until noon, Sept. 22, by J. T. Hanson, M. D., Secretary Trustees Athens State Hospital, for materials and labor for installing new boilers at State Hospital, Frank L. Packard, Architect, Columbus, O.

Cincinnati, O.—Machine Tools.—Until noon, Sept. 22, by Trustees Commissioners of Water Works, Elmer C. Prior, Clerk, for the construction and delivery of machine tools and other appurtenances for the several pumping stations, the filter plant and the intake pier of the city.

Columbus Barracks, O.—Electric Elevator. Until 10 a. m., Sept. 10, by Capt. H. J. Hirsch, Constructing Q. M., for furnishing an electric elevator for new hospital at Columbus Barracks.

Harrisburg, Pa.—Vacuum System.—Until Sept. 8, by Samuel R. Ranbo, Superintendent Public Grounds and Buildings, for installing vacuum and compressed air cleaning system in State Capitol and State Library Museum.

Cumberland, Wis.—Generators, Etc.—Until 8 p. m., Sept. 11, by A. F. Wright, City Clerk, for changes, improvements and additions to the electric light and water works plant, the work comprising in the main the furnishing and installation of one or two, three-phase generators (capacity 75 and 100 K.W.), direct connected to Corliss type engines of equal capacity, brick building, motor driven triplex pump, condenser, heater, boiler, feed pump and various other auxiliaries. Oscar Claussen, Consulting Engineer, St. Paul, Minn.

CONTRACTS LET.

The following contracts have been let recently:

Greenway, Ark.—Ditch Work—Contracts for constructing main ditch and laterals of Clay County Drainage District No. 5, J. D. Mitchell, Engineer, were awarded on Aug. 20 to J. S. Simpson and I. C. Leggett, of Rector, Ark., at following bid: Main ditch, 6 miles (200,000 cu. yds.), \$0.093; laterals, 5 miles (50,000 cu. yds.), \$0.20. Main ditch is dredge work and laterals team work. Price includes clearing of right of way.

Marysville, Cal.—Bridge.—Western Bridge & Construction Co., at \$3,525 for substructure and \$3,150 for concrete abutments, for county bridge over Simmerly Slough.

Sacramento, Cal.—Sewers. Cotton Bros. & Co., Ashland, Cal., at following bids for constructing sections of reinforced concrete monolithic sewer: Sec. 1, \$15,233; Sec. 2, \$9,115; Sec. 3, \$8,991; Sec. 4, \$11,211; Sec. 5, \$8,208; Sec. 6, \$15,786; Sec. 7, \$9,241; Sec. 8, \$5,739. For constructing trunk line sewer of plain monolithic concrete contracts were let as follows: Sec. 9, Williams & Belsey, \$4,150; Sec. 10, T. E. Clark, \$1,431; Sec. 11, T. M. Burns, \$5,637. For laterals, main sewers of plain monolithic concrete and vitrified iron pipe, T. E. Clark was awarded contract at \$3,818. For lateral main sewers of vitrified iron pipe contracts were let to: 12th St., Cotton Bros. & Co., \$1,885; 15th St., McGillicray Co., \$2,111; 19th St., Cotton Bros. & Co., \$1,885; 24th St., Cotton Bros. & Co., \$1,190; 25th St., Cotton Bros. & Co., \$1,865; 29th

St., South Cotton Bros. & Co., \$5,366; 29th St., North, Chas. Moore & Son, \$2,751; McKinley Park, Chas. Moore & Son, \$1,119.

San Francisco, Cal.—Sewer, Paving.—J. A. Dowling, at \$5,775, for sewer in Sacramento St.; G. W. McGillicray & Co., at \$7,852, for gasalt black pavement on concrete foundation on Minna St.

Florence, Colo.—Bridge.—Fox & Smith, Florence, at about \$2,500, for concrete bridge over Oak Creek, near Williamsburg.

De Funiak Springs, Fla.—Water Works.—J. B. McCrary & Co., Atlanta, Ga., for water works for this place.

Rome, Ga.—Paving. Georgia Engineering & Construction Co., at \$103,500, for 41,000 sq. yds. brick paving on concrete base for city.

Villisca, Ia.—Opera House.—L. D. Ashby, Red Oak, Ia., for building opera house here.

Kuna, Idaho.—Bridge.—Newton J. Pethel, for building wagon bridge over Indian Creek at this place.

Alton, Ill.—Sewer.—Fred Gerdes at following bid for constructing North St. sewer: 22-in. pipe, \$1.19 per ft.; 20-in. pipe, \$1.06; 18-in. pipe, 76 cents; 12-in. pipe, 49 cents; 10-in. pipe, 42½ cents; and 8-in. pipe, 27½ cents. Contract amounts to about \$10,000.

Aurora, Ill.—Bridges.—Roemheld Construction Co., 171 La Salle St., Chicago, Ill., at \$37,882 for cast bridge over Fox River, and \$21,733 for west bridge.

Champaign, Ill.—Bridge. Elkhart Bridge Co., Elkhart, Ind., at \$5,013, for 144x11 ft. iron bridge to be erected over the Sangamon River in Newcomb Township.

Chicago, Ill.—Paving.—Citizens' Construction Co., 138 Washington St., for paving on West 81st St., with vitrified brick on 6-in. concrete base.

Colchester, Ill.—Sewer.—Frank Dunsworth at \$5.25 per rod for constructing sewer for this place.

Creston, Ill.—Water Mains. Bellis & Gale, Oregon, Ill., for extending water mains.

Litchfield, Ill.—Sewer.—Federal Improvement Co., 145 La Salle St., Chicago, Ill., at \$27,896, for constructing sewer for city.

Macomb, Ill.—Sewer.—Claude R. Butcher, at \$3,812, for laying sewer and laterals in North Mechanic St.

Virginia, Ill.—Bridge.—Illinois Bridge Co., Jacksonville, Ill., at \$1,085, for three 30-ft. steel bridges for county.

Indianapolis, Ind.—Sewers.—O'Donnell & Co., at \$1.33 per lin. ft. for sewer in St. Peter St.; Schauer & Roesinger at \$1.53 per lin. ft. for sewer in Oxford St.

Lafayette, Ind.—Bridge.—Lafayette Engineering Co., Lafayette, Ind., for 60-ft. bridge with concrete floor to be erected on Davis Ferry Road over Copperhead Pond.

Seymour, Ind.—Sewer.—De Golyer & Walsh at following bid for constructing sewer in Central Ave.: Main sewer, 1,950 feet, 10 in. tile, at 35 cts. per lin. ft. and 60 cts. for each T and V; 1,685 ft. of laterals, 8 in. tile at 30 cts. per lin. ft. and 45 cts. for each T and V.

Leavenworth, Kan.—Bridge.—Leavenworth Bridge Co., at \$5,000 for new bridge over Big Stranger Creek at Wells site.

Boston, Mass.—Conduit.—Coughlin & Shields, Boston, Mass., at \$102,100, for constructing Stony Brook conduit for city.

Baltimore, Md.—Paving.—Warren Bros., Boston, Mass., for paving several streets with bitulithic at following bids: 7th St., \$10,005; 8th St., \$9,695; Clifton Ave., \$10,051; Walbrook Ave., \$15,302.

Towson, Md.—Bridge Work, Etc.—Harry T. Campbell at following bid for excavating and bridge work on Taylor Ave. for county: 32 cts. per cu. yd. for excavation, \$9 per cu. yd. for reinforced concrete and \$4.50 per cu. yd. for plain concrete.

Medford, Mass.—School.—McGahey & O'Connor for the new Lorn L. Dame Grammar school at this city.

Ann Arbor, Mich.—Bridge.—Slater Construction Co., at \$7,493, for constructing Race St. bridge for city.

Hancock, Mich.—Sewer.—Phil O. Sheridan, Hancock, at \$6,968, for labor and construction of West Hancock sewer system.

Ishpeming, Mich.—Sewers.—Johnson & Munson having withdrawn their bid for constructing sewers for this place, the contract has been let to E. R. Harding, Racine, Wis., at \$12,641.

St. Joseph, Mich.—Bridge.—Joliet Bridge & Iron Works, Joliet, Ill., at \$11,000, for superstructure of bridge over St. Joe River at State St. J. A. Almendinger, at \$35,000 was awarded contract for substructure.

Litchfield, Minn.—School.—J. Shelde, for erecting school house here.

Minneapolis, Minn.—Building Work.—Wm. M. Crawford & Son, for interior improvements and changes in Lyceum theatre.

Rapidan, Minn.—Bridge, Culvert.—Hennepin Bridge Co., Minneapolis, Minn., for one steel bridge with a 16-ft. span, with steel filling and concrete backing, also four corrugated steel culverts with stone facing and three stone culverts for town.

Brooklyn, N. Y.—Warehouse.—Turner Construction Co., 11 Broadway, New York, general contract for the construction of a reinforced concrete warehouse one story high, 90 ft. by 190 ft. in plan, for the Hardy-Voorhees Co., Richard A. Wright, Engineer, at Metropolitan Ave., near Newtown Creek, Brooklyn. This building will have 30 ft. clear spans. Work has just been started.

Rensselaer, N. Y.—Paving, Etc.—James L. Witte & Co., Rensselaer, for paving and grading Riverside Ave., Washington St. and Third Ave., and the replacing of granite block pavement on Tracey St.

Penn Yan, N. Y.—Pier, Etc.—Henry Tosh & Son, Port Byron, N. Y., at \$2,600, for constructing a pier and building light house foundation for state.

Syracuse, N. Y.—Delivering Pine.—William Ledy, Camillus, N. Y., at \$18,366, for delivering pine for Skaneateles Lake conduit line for city.

Seneca Falls, N. Y.—Sewage Disposal Plant.—C. T. Hookway, Syracuse, N. Y., at \$7,650, for constructing sewage disposal plant for this city.

Dayton, O.—Sewer.—Oscar Helping, at \$1.63 per lin. ft., for constructing 1100 ft. of sewer at county infirmary.

Lima, O.—Hospital Buildings.—National Concrete Fire Proof Co., at \$142,000, for constructing buildings for state hospital near this place.

Springfield, O.—Bridge.—Home Engineering & Construction Co., Canton, O., at \$11,357, for constructing Greeting bridge in Pike Township; Charles Bird, at \$5.95 per cu. yd., for substructure.

Erie, Pa.—Paving.—Mayer Bros., for paving on French St.

Jeanesville, Pa.—Stripping.—Charles Kehue & Co., Hazleton, Pa., for stripping large area of land near this place for the Lehigh Valley Coal Co.

Pittston, Pa.—School Buildings.—Sax & Abbott, Philadelphia, Pa., at \$76,250, for constructing two school buildings.

Philadelphia, Pa.—Fire House.—J. R. Wiggins, 1215 Filbert St., for erection of a fire house at 6th and Locust Sts.

Memphis, Tenn.—Paving.—Bids were opened Aug. 24, by J. H. Weatherford, City Engineer, for paving Madison Ave. as follows: (1) H. P. Streicher, Toledo, O., (2) Barber Asphalt Paving Co., Cincinnati, O., (3) Memphis Asphalt & Paving Co., Memphis, Tenn.:

	(1)	(2)	(3)
Grading, 40,000 yds.	\$0.24	\$0.50	\$0.13
Concrete foundation, ...			
65,000 yds.	.62	.72	.70
Asphalt top, 65,000			
yds.	1.28	1.49	1.42
Maintenance	.05	.10	.05
Trees	5.00	5.00	5.00

Totals \$136,350 \$174,150 \$158,250

Marlin, Tex.—Bridge Work.—Morava Construction Co., 204 Dearborn St., Chicago, Ill., at \$33,000, for construction of bridge over Brazos River at Belton Crossing; Mississippi Valley Bridge Co., Leavenworth, Kan., at \$6,092, for repairs to bridge over Brazos River, near High Banks.

Brownsville, Tex.—Railroad Work.—Sam Robertson, Brownsville, for building 15 miles of railroad from near Ebenezer in Hidalgo County.

Richmond, Va.—The Richmond, Fredericksburg & Potomac Ry. is now installing a ballast plant and about Nov. 1 will begin ballasting its entire line. S. F. Rice, Richmond, Va., is Road Master.

Portsmouth, Va.—Sewers.—Bryan & Co., Jacksonville, Fla., at \$68,000, for constructing 5th Ward sewer system.

Seattle, Wash.—Trestle.—W. G. Head, at \$1.72, for building trestle approach to Black Diamond bridge.

Milwaukee, Wis.—Bridge.—H. C. Fuldner, at \$3,793, for constructing concrete bridge over Kinnickinnie River at Midland Ave.

Havana, Cuba.—Paving, Sewers.—Arrangements have been effected between the Republic of Cuba and the McGivney & Rokeby Construction Co., 1 Broadway, New York, to carry out the contract made in 1902 for constructing sewers and paving the streets. The sewer portion of the work will be carried out by the Cuban Engineering & Contracting Co., a recently organized corporation of which D. L. Hough, 32 E. 33d St., New York, is Managing Director. The Cyalde Asphalt Paving Co., 1 Broadway, New York, will carry out the paving portion of the work. The contracts are reported to amount to about \$16,000,000.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States.

Stockton, Cal.—San Joaquin and Sacramento counties propose to construct bridge over Mokelumne River. F. E. Quail County Surveyor, estimates the cost at \$10,000.

Denver, Colo.—City will take steps soon for commencing construction work on the 20th St. viaduct.

Pensacola, Fla.—A special county election is to be held Nov. 12 to vote on issuing \$200,000 of bonds, part of which will go for constructing bridges and roads.

Sioux City, Ia.—City Engineer has prepared plans and specifications for a reinforced concrete viaduct to be erected over the railroad track at Wall St. at a cost of about \$180,000.

Aurora, Ill.—City Park Commissioners are to build ornamental concrete bridge over the lagoon at Phillips' Park.

Handsboro, Miss.—Village has voted \$6,500 of bonds for building bridge over Bayou Bernard.

Kansas City, Mo.—Missouri Pacific and Union Pacific Railroads may combine to build a bridge over the Kaw River. E. S. Mitchell, St. Louis, Mo., is Engineer of Construction. M. P. Ry.

Springfield, Mo.—County Court is considering erecting steel bridge over the James River on the North Hartville Road, 15 miles from this city.

Alliance, O.—City proposes to construct new concrete bridge at Oxford St.

Dayton, O.—County Commissioners propose to construct reinforced concrete bridge over the Miami River on the Needmore Road in Harrison Township. Bridge will cost about \$18,000. Howard R. Klejinger is County Engineer.

Defiance, O.—City Engineer Tobertan has prepared preliminary plans for a lift bridge to be erected over the canal at 5th St. at an estimated cost of \$5,500.

Youngstown, O.—Frank Lillie, City Engineer, has completed plans for proposed overhead bridge at Springs Common.

Zanesville, O.—County Commissioner will erect a steel bridge at Philo to replace the two wooden spans swept out by storm last week.

Sapulpa, Okla.—St. Louis & San Francisco R. R. is to build two viaducts, 24 ft. wide over its tracks in this city. City will build the approaches. F. S. Rice is Engineer of Bridges. St. L. & S. F. R. R.

Glendon, Pa.—County, Lehigh Valley R. R., and Lehigh Coal & Navigation Co., are to build an \$18,000 bridge over the canal at Glendon. L. A. Francisco, Easton, Pa., is County Engineer.

Westfield, Pa.—Village will pay one-third cost of bridge to be built over the Chautauqua gorge by local trolley line. Bridge will cost about \$10,000.

Austin, Tex.—Hearing was held Aug. 22, by County Commissioners to consider expenditure of \$300,000 bond issue voted for bridge and road work. The principal bridge will be erected over Colorado River at Congress Ave.

Marlin, Tex.—County proposes a \$50,000 bond issue for construction of a new bridge over the Brazos River to replace the structure washed out by recent floods.

Hillsboro, Tex.—Hill and Bosque Counties are considering bridge over Brazos River on boundary line between the two counties.

Beloit, Wis.—City Council is considering erecting \$10,000 bridge.

Chippewa Falls, Wis.—City Engineer Kirk has prepared plans for a new bridge over the Chippewa River, estimated to cost about \$35,000.

Railroads.

Items Arranged Alphabetically by States.

Jasper, Ala.—Surveys are being made for an extension of the Alabama Central R. R. from Manchester to Falls City. A Russell, Jasper, Ala., is General Manager.

Harrison, Ark.—Choctaw Coal & Development Co., Sulphur, Okla., proposes the construction of a standard gage railroad from Bergman to Harrison a distance of ten miles. H. G. Leake, Fort Worth, Tex., is Engineer.

Los Angeles, Cal.—A syndicate represented by A. B. Salisbury has purchased from F. B. Yokum the property known as Lookout Mountain Park for \$98,000. The new owners propose to build a scenic railway up Laurel canyon and to make a pleasure resort of the place.

Salida, Colo.—Advices from this city state that the Denver & Rio Grande R. R. has had

plans drawn for a track 325x150 ft. shop to supplant the present three pit shops at this place. The shop will have a ten pit equipment with two electric cranes. Thos. B. Purver, Jr., Burnham, Denver, Colo., is Superintendent Motive Power.

Tampa, Fla.—Receivers of Seaboard Air Line Ry. have appropriated \$500,000 for terminal improvements at this place. V. E. McBoe, Jr., Jacksonville, Fla., is Assistant Engineer, Seaboard Air Line Ry.

Brooksville, Fla.—Preliminary plans are stated to have been agreed upon for the extension of the Tampa Northern Ry. from Brooksville, Fla., to Thomasville, Ga., connecting with the Atlanta, Birmingham & Atlantic R. R. The Tampa Northern is now being operated to Brooksville, 50 miles north of Tampa. It is proposed to extend the road from Brooksville to Dunnellon, Fla., at once. The construction of the road, north of Dunnellon will be taken up after the extension of that place has been completed. The distance from Dunnellon to Thomasville, Ga., is about 150 miles. The construction of the extension will be in charge of Captain W. B. Denham, Tampa, Fla., General Manager of the Tampa Northern R. R.

Charlton, Ia.—Waterloo, Pella & Southwestern Ry. Co. is stated to have completed all preliminary work for its proposed line from this place to Waterloo, and is now seeking permission to increase its capital stock to \$5,250,000 and to issue \$3,500,000 in bonds for the construction. The road, as proposed, is to be 120 miles long, and the estimated cost of construction is \$31,000 per mile. The company proposes to maintain a regular steam railroad passenger and freight service and will also add a motor or local suburban service. B. F. Keables, Pella, Ia., is President.

Walnut, Ia.—Iowa & Omaha Short Line Ry. Co. has been incorporated with a capital stock of \$1,000,000 and proposes to build a line 140 miles long to extend from Omaha to Des Moines, through the counties of Pottawattamie, Shelby, Audubon, Guthrie, Dall and Polk, Iowa. The business office is to be at Walnut, Iowa. The incorporators are George W. Adams, Walnut, Ia.; Arthur E. Saar, A. L. Ingram, Peter Kathmann, F. H. Schultz, Teynor, Ia.; C. L. Kirkwood, L. B. Spangler, Adrian, Ia.; G. L. Artist, North Branch, Ia.; John A. Holmes, of Pierre, S. Dak.

Wichita, Kan.—Local press reports quote Lebar Tompkins, General Counsel, Kansas Southern & Gulf R. R., as stating that a project for the construction of a railroad from Omaha to Wichita has already been financed. The line, if built, will be 274 miles long.

Thompsonville, Mich.—Ann Arbor R. R. Jos. Wambert, Resident Engineer, Toledo, O., has commenced laying track for its 40 mile extension north from this place. Other extensions are to be made, it is said.

Whittier, N. C.—Surveys are stated to have been made for the construction of the Appalachian Ry. recently organized here to build a railroad 50 or 60 miles long from this place to the Great Smoky Mountains, and across them, with the western terminal at Sevierville, Tenn. John C. Arbogast, Lake Chester, La., is General Manager.

Holdrege, Neb.—Western Central R. R. Co. has been incorporated and proposes to build a railroad from this place to Kearney with branch lines to other towns. Surveys have been started and it is said that construction work will be started soon. Capital stock is \$250,000 and headquarters are in Omaha. The incorporators are: T. E. Brady, Charles Stanton, J. G. Burlingham, E. O. Carlson and S. C. Nelson, all of Omaha.

Albuquerque, N. Mex.—A syndicate of western bankers and A. L. Richmond, Jr., Pittsburg, Pa., are stated to have purchased \$1,600,000 of first mortgage bonds of the proposed Albuquerque & Eastern R. R., and will build 65 miles of railroad from Moriarity, of the New Mexico Central R. R. to Frost, and from that point west to Albuquerque and north to Hagan.

Akron, O.—Advices from this city state that the Akron, Canton & Youngstown Ry. Co. organized some years ago by Canton, O., and eastern capitalists, is to build a steam road from Akron to Mogadore as an extension of the Lake Erie & Western which runs from Delphos through Medina to this city. Construction of the line to Mogadore is to be started as soon as remaining right of ways is secured.

Ashland, O.—Chesapeake & Ohio Ry. is to dispose of a \$4,000,000 first mortgage bond issue for the purpose of constructing a line from near Ashland to Elkhorn, Va., a distance of 70 miles, with a nine mile branch. H. Pierce, Richmond, Va., is Engineer of Construction. C. & O. Ry.

Norwalk, O.—Repair shops of the Wheeling & Lake Erie R. R. in this city consisting of the blacksmith machine, boiler and carpenter shops, power house, store house and

flce were destroyed by fire Aug. 23, causing a loss of \$300,000. Local press reports quote R. A. Worthington, Pittsburg, Pa., Receiver for the Wheeling & Lake Erie as stating that if Norwalk will make a suitable proposition in the way of land and money to the owners of the road he will recommend that nearly all of the \$1,800,000 which the plans for the general shops at Brewster call for be expended in locating the general shops at this place.

Indiana, Pa.—Agents of the Buffalo, Rochester & Pittsburg R. R. Co. are said to have taken options on considerable property in Indiana County to be utilized in the building of small branch roads to tap new coal fields. E. F. Robinson, Rochester, N. Y., is Chief Engineer.

New Milford, Pa.—Delaware, Lackawanna & Western R. R., Lincoln Bush, Chief Engineer, Hoboken, N. J., is stated to be having surveys made for a line between Clark's Summit and New Milford which will eliminate the grades and curves between these two points. The improvement would cost about \$7,000,000.

Electric Railways.

Items Arranged Alphabetically by States.

Huntsville, Ala.—City Council has granted franchise to Edward L. Pulley to construct and operate an electric railway on Madison St. or Oak Ave., Gallatin, Holmes and Church Sts., and establish and operate an electric light and power plant in the city. Right of way for part of line has been granted and most of the material secured.

Chico, Cal.—Grading work will probably be started this fall on the proposed extension to Colusa and to Red Bluff of the electric railway of which A. D. Schindler is General Manager.

Oakland, Cal.—Surveys have been completed for the projected electric railway from Oakland to Antioch, and necessary capital for the construction of the road is said to have been secured. The project is being promoted by A. W. Maltby and Joseph Naphitaly.

Boone, Ia.—Surveys have been completed for the proposed electric railway from this place to Eldora.

Des Moines, Ia.—The Iowa Interstate Ry. Co. has been organized here and proposes to construct a road from Council Bluffs to Muscatine by way of Des Moines. The portion between Des Moines and Council Bluffs will be built first. From Springhill the line, as proposed will run west through Winterset, Greenfield, Fontanelle, Cumberland, Lewis and Oakland, and thence direct to Council Bluffs. The eastern section of the line to be built later will run almost due east from Springhill to Muscatine, via Indianola, Knoxville, Oskaloosa, Signourney and Washington. The promoters state that final arrangements for necessary capital have been secured. Engineer has been selected. R. B. Bannister 511 Manhattan Bldg., Des Moines, is Secretary.

Sioux City, Ia.—Sioux City Traction Co., M. W. Lake, Chief Engineer will shortly begin the construction of extensions to its lines, authorized by a new franchise.

Grangeville, Idaho.—Proposition has been made to local Commercial Club by O. G. Kinney of the Hogan Mines, near Elk City, for the construction of an electric railway between this place and Elk City.

Springfield, Ill.—It is now said that the Illinois Central Traction Co., Decatur, Ill., will not commence work on its new line from Springfield to Petersburg until next spring.

Danville, Ind.—Surveys are stated to have been made for an extension of the Indianapolis & Danville traction line from Danville to Rockville, 55 miles west of this place.

Seymour, Ind.—The Seymour & Brownstown Construction Co. has been organized to construct an electric railway between this city and Brownstown, a distance of twelve miles. An ordinance for an entrance into this city is pending before the City Council. Surveys are to be made at once.

Louisville, Ky.—The Louisville Railway Company has filed an amendment to its articles of incorporation today, providing for an increase of \$500,000 in the capital stock of the company.

Houghton, Mich.—The Houghton County Traction Co., capitalized at \$2,850,000, has been organized by Stone & Webster, Boston, Mass., for the purpose of taking over the Houghton County Street Ry. Co. and to build the Wolverine to Mohawk and other extensions.

Kalamazoo, Mich.—Michigan United Ry. Co., Lansing, Mich., has asked City Council for permission to double track its line on North Burdick St.

Glencoe, Minn.—Estimates have been made for constructing a gasoline motor road from

this place to New Auburn, a distance of 10 miles. It is estimated that road can be built for about \$5,000 per mile.

East St. Louis, Mo.—Southern Traction Co. of Illinois, L. D. Mephian, Jr., President, which is building an electric railway into the coal fields of Southern Illinois, has tracks laid for its line in East St. Louis and Le Belleville, and will it is said, shortly award a contract for building the road to connect these two cities. Ultimately, the line will be extended south from Belleville, probably as far as Picekneyville. The company is seeking entrance to St. Louis, Mo., over the new municipal bridge to be erected by that city.

Marion, O.—The Marion & Gallon Electric Ry. Co. has been incorporated by F. H. Murphy and others of Cleveland, to construct and operate an interurban line between Marion and Gallon. The company is capitalized at \$10,000, and it is said that construction work will be begun within a short time.

Indiana, Pa.—As soon as right of way can be secured the Indiana Street Ry. Co. will award a contract for constructing an extension to Blairsville.

Appleton, Wis.—Action is to be taken shortly looking to the building of an interurban line from Appleton to New London via Hortonville. This line is to be built by a local company and will probably be operated by gasoline motors at first.

Kilbourn, Wis.—The Central Wisconsin Transit Co. has been incorporated. The place of business is at Kilbourn and the capital stock is \$25,000. The proposed road will be from Kilbourn through Adams County by way of Friendship into Wood County, the terminal being at Grand Rapids, a distance of about 65 miles. The incorporators are J. J. Burns, C. F. Burns, George H. Campbell, William Sweet and C. B. Wintermute and the road is reported to have been financed by the St. Paul R. R.

Sewers.

Items Arranged Alphabetically by States.

Birmingham, Ala.—Plans and specifications are being completed for city's new system of sanitary and storm sewers.

Montgomery, Ala.—An election is to be held Sept. 21 to vote on a bond issue of \$250,000 for construction of school buildings, extending water works, building a city warehouse and wharf and extending sanitary sewerage.

Selma, Ala.—Plans are being discussed for constructing 2½ mile sewer through North Selma. V. B. Atkins is Mayor.

Newport, Ark.—Lund & Hill, Little Rock, Ark., are preparing plans for sewer system for this city.

Berkeley, Cal.—Town Board is to be asked to extend outlets of West Berkeley sewers to deer water.

San Diego, Cal.—City Engineer Crowell has completed plans and specifications for the construction of the general sewer system improvements provided for in bond issue.

Willows, Cal.—Special election is to be held soon to vote on issuing \$30,000 of bonds for installing sewer system.

Decatur, Ill.—Board Local Improvements has passed resolution for construction of sewer to cost \$2,310.

Mount Morris, Ill.—Village Trustees have appropriated \$175 to secure engineer to make surveys and estimates for a sewer system.

Wyoming, Ill.—Local sewer is to be extended.

Princeton, Ind.—Final hearing on construction of proposed \$70,000 sanitary sewer system for this city is to be held Sept. 21.

Atchison, Kan.—Construction of sewer for St. Benedict's College is under consideration. Sewer would cost about \$5,000.

Louisville, Ky.—The following were bidders Aug. 21 for the construction of Sec. D of the southern out-fall sewer: E. G. Nave Bros. & Co., Portsmouth, O.; Weber & Co., Memphis, Tenn.; Ferro Concrete Construction Co., Cincinnati, and Henry Bickel Co., Louisville.

Louisville, Ky.—Sewerage Commission will shortly call for bids for constructing Sec. 3 of the southern out-fall sewer.

Nashville, Mich.—Village Council has completed arrangements for a sewer system. R. E. Harrison, Toledo, O., will be in charge.

Eveleth, Minn.—City will probably construct a sewer in Monroe St.

St. Paul, Minn.—Board Public Works has reported in favor of constructing sewers in Fairview Ave. and Amherst Ave. at a cost of \$15,692.

Butte, Mont.—City Council has rejected bids received Aug. 12, for constructing sewer in Antimony St. at an estimated cost of

\$1,750 and a sewer in Henry St., estimated to cost \$3,000.

Paterson, N. J.—Board of Finance and Special Sewerage Committee will on Sept. 10, consider offer of a New York sewage disposal company to install a disposal plant for this city to cost \$2,000,000.

Dunkirk, N. Y.—The laying of a trunk sewer to care for the sewers leading to the lake front has been recommended for this city. The sewer would cost about \$500,000 and consequently nothing will probably be done for some time.

Ashtabula, O.—City Engineer Amsden is working on plans for sewer work in Sewer District No. 3.

Lorain, O.—Council has passed an ordinance providing for the issuance of bonds to the amount of \$26,000 for the construction of sewers on Oberlin, Hoyt and Allen Sts.

Salem, O.—Following were low bidders Aug. 20 for sewer work here: West Main St. sewer, John Gunn, \$3,426; Perry St. John Devine, \$2,359; Washington and Evans Sts., John Gunn, \$2,157; Sugar Tree Alley, John Gunn, \$519; East 4th St., John Wilson, \$1,284; Euclid, Penn and Lundy Sts., John Gunn, \$3,400.

Canonsburg, Pa.—State Health Department has approved plans for joint sewage disposal for this place and South Canonsburg.

Cheswick, Pa.—State Health Department has ordered this place to prepare new plans for sewage disposal and has refused it permission to build sewers until this is done.

Connellsville, Pa.—City has been granted permission by State Health Department to build three small sewers until plans for a sewage disposal are completed.

Camp Hill, Pa.—State Health Department has directed this borough to prepare plans for sewer system and disposal works.

Lamoyne, Pa.—Borough has been directed to have plans made for sewerage and sewage disposal works.

New Cumberland, Pa.—Plans for sewer system and disposal work for this borough must be made according to an order of the State Health Department.

Swathmore, Pa.—State Health Department has directed this place to have plans prepared for sewage disposal.

Wormleysburg, Pa.—State Health Department has directed this borough to have plans prepared for sewer system and sewage disposal work.

Youngwood, Pa.—Borough has been granted permit to build sewers.

White Haven, Pa.—Borough is considering installing sewers and sewage disposal plant.

Orange, Tex.—J. E. Milliken, City Engineer, has completed surveys for a 15 in. tile storm sewer in business section of 5th St.

Ritzville, Wash.—Sewer system is to be extended to Nob Hill at a cost of \$1,000.

Kaukauna, Wis.—State Board of Health has directed this city to change outlet of one of its sewers.

Water Supply.

Items Arranged Alphabetically by States.

Glendora, Cal.—Glendora-Azusa Water Company has decided to instal new pumping plant and build new water main to increase the capacity of the system.

Sacramento, Cal.—Board of City Trustees have again taken up matter of securing clear water supply for city. Some system of filtration is proposed.

Burlington, Ia.—Citizens' Water Co. will lay water mains in Ashmun St. from North Oak to Linden Sts.

Lake Park, Ia.—Town will vote Sept. 14 on issuing \$6,500 of bonds for extending its water system.

Shoshone, Idaho.—Duplicate pumping plant is to be installed for the city water works.

Norway, Mich.—City on Sept. 10 will sell \$57,000 of water works extension bonds.

Braymen, Mo.—Matter of installing city water works is under discussion.

Lake Crystal, Minn.—Village has voted to erect a standpipe for water works and extend the water mains at a cost of \$5,300.

Midland Park, N. J.—Bergen Water Co. has been incorporated with a capital stock of \$25,000 by F. Bergen to operate water works in this place.

Hamilton, O.—A \$50,000 bond issue has been voted for extending water works service to newly annexed territory.

Delaware, O.—Delaware Water Works Co. is said to be contemplating improvements for increasing its supply. Two plans are said to be under consideration, the digging of three new wells, or the erection of a tank about 100 ft. high, to which the water will be pumped from the river, and allowed to flow

through beds of sand as it passes from the tank. It is also stated that a larger compressor is contemplated.

Dayton, O.—Arthur Geisley, Consulting Engineer, has made a report to the Board Public Service regarding increased water supply for city. Additional wells will have to be sunk to secure the supply, which it is estimated will cost the city about \$350,000.

Terrace Park, O.—Terrace Park Co-operative Water Co. has been incorporated with a capital stock of \$5,000 by O. T. Robertson, Chas. A. Myers, Jr., R. S. Mager and others.

Wellsville, O.—Board of Public Service has authorized the expenditure of about \$8,000 for the construction of six new wells in the river bed. L. E. Chapin, Canton, O., is Engineer.

Worthington, O.—Village has granted franchise for water works to Bond S. Neff.

Pryor Creek, Okla.—Election will be held to vote on issuing \$75,000 in bonds for installing a water system.

Hastings, Okla.—Election will be held to vote on bond issue of \$27,000 to install a water system.

Harrisburg, Pa.—State Water Supply Commission has approved the following applications for charters: Biglerville Water Co., Biglerville, Adams County; Bensalem Water Co., Bensalem, Bucks County; Yeagertown Water Power Co., Derry Township, Midlin County.

Pendleton, Ore.—Wenaha Water & Power Co., of this city, has been incorporated with a capital stock of \$10,000 by J. A. Borie, T. J. Morris and Frank O. Rogers.

Sparta, Tenn.—Sparta Water Co. has been incorporated with a capital stock of \$3,000 by R. F. Baker, S. J. Jackson, D. M. Meredith and others.

Kaysville, Utah.—City has granted franchise for water works to Heber J. Steiner.

La Crosse, Wis.—Water works extensions are to be made at a cost of \$10,000.

Mobridge, S. Dak.—City has voted to install water works.

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PAVING.

Muskogee, Okla.

Bids will be received until September 8th for fifty thousand (50,000) yards of Bituminous Concrete Pavement.

L. B. KINSEY,
City Engineer.

REMODELING COURTHOUSE.

Washington, Ind.

Bids are asked by the Commissioners of Daviess County until Sept. 9, for remodeling the County Courthouse. For particulars address

THOMAS NUGENT,
County Auditor.

DAM AND RESERVOIR.

Cimarron, N. M.

Bids are wanted for the construction of a large rock fill and reinforced concrete dam and reservoir in Colfax County, New Mexico. For plans and specifications address

E. H. FISHER,
Cimarron, N. M.

MACADAM ROADS.

Decatur, Ala.

Sealed proposals for construction of a system of macadam roads in Morgan County, Ala., will be received at office of undersigned until Monday, September 14th, 1908; \$240,000 to be expended. Plans and specifications on file for first 30 miles after September 1st.

WILLIAM E. SKEGGS,
Judge of Probate.

COMBINED SANITARY AND STORM SEWERS.

Upper Sandusky, Ohio.

Sealed proposals will be received by the undersigned at the office of the Village Clerk of Upper Sandusky, Wyandotte County, Ohio, until twelve (12) o'clock noon of Tuesday, September 15th, 1908, then and there to be publicly opened and read, for the construction of about 5,275 feet of combined sanitary and storm sewers, with the necessary appurtenances. Size of sewers ranges from 20 to 48 inches in diameter, those 30 inches and under to be vitrified pipe and above 30 inches of reinforced concrete, brick, or vitrified pipe.

All proposals to be made on blanks furnished by the village.

Each bidder will accompany bid with a deposit of \$2,500.00 or a certified check for like amount, payable to order of undersigned, as a guaranty that within ten (10) days after the acceptance of his bid he will enter into a contract with the Village and execute a surety company bond for an amount equal to 40 per cent thereof.

Bidders are required to personally look over the work before bidding.

Plans and specifications can be seen and bidding blanks obtained at the office of the undersigned, or from The Riggs & Sherman Co., Engineers, Toledo, Ohio.

The Village Council reserves the right to reject any or all bids.

Dated the 26th day of August, 1908.

A. H. STUTZ,
Village Clerk.

CONCRETE RESERVOIR.

Gulfport, Miss.

Sealed proposals will be received by the Mayor and Board of Aldermen of the City of Gulfport, Miss., until 8 o'clock p. m., September 15th, 1908, for the construction of a reinforced concrete reservoir, in accordance with the plans and specifications on file in the office of the City Engineer.

Specifications and blank forms of proposal, contract and bond, will be furnished prospective bidders upon application to the City Engineer.

The right is reserved to accept any bid or to reject any or all bids.

J. W. THOMAS, Mayor.
M. F. SULLIVAN, City Engineer

PUMPING MACHINERY.

Muskegon, Mich.

Sealed bids will be received up to twelve o'clock noon, Sept. 8, 1908, by B. H. Telfman, City Recorder, Muskegon, Michigan, for a vertical pump of six million (6,000,000) gallons capacity in twenty-four (24) hours, to be installed at the Water Works at the Lake Michigan Pumping Station. General specifications of same are on file and copy of same will be mailed on request of bidders.

Each bidder to furnish specifications of his pump and bid in detail, and the total cost of installing the same.

The city reserves the right to reject any and all bids.

BENJ. H. TELLMAN, Recorder.

DITCH WORK.

Utica, Nebraska.

Bids are asked until Sept. 18, 1908, by the Utica Drainage District, Utica, Neb., for construction of 30-inch, No. 2 glazed sewer tile ditch, 3,850 feet long, from 8 to 29 feet under ground, and for open ditch one mile long, 8,000 yards of dirt to remove. Estimate of cost, \$12,319.

UTICA DRAINAGE DISTRICT,
Utica, Neb.

U. S. ENGINEER OFFICE, Vicksburg, Miss., August 17, 1908. Sealed proposals for furnishing Portland cement for use in construction of Lock and Dam, No. 8, Ouachita River, Ark., will be received here until noon, September 8, 1908, and then publicly opened. Information on application. CLARKE S. SMITH, Capt. Engrs.

OFFICE CONSTRUCTING QUARTERMAS-ter, Fort Leavenworth, Kansas, August 27, 1908. Sealed proposals, in triplicate, will be received here until 11:00 a. m., Central Time, September 16, 1908, and then opened, for the construction of an Isolation Hospital, including plumbing, hot water heating, electric wiring and electric lighting fixtures, at Fort Leavenworth, Kansas. Full information and blank forms of proposal furnished on application to this office. Plans and specifications may be seen here; also in offices of Chief Quartermaster at Omaha, St. Paul, Denver and Chicago, Depot Quartermaster, Saint Louis, and Secretary Master Builders' Exchange, Kansas City, Mo. United States reserves the right to accept or reject any or all proposals or any part thereof. Envelopes to be endorsed "Proposals for Isolation Hospital," and addressed to Captain Wm. D. Davis, Quartermaster.

CONSTRUCTION OF BUILDING. OFFICE of Constructing Quartermaster, Columbus Barracks, Ohio, August 26, 1908. Sealed proposals, in triplicate, will be received here until 10 a. m., Standard Time, September 15, 1908, and then opened, for construction of one double set Hospital Corps Sergeants' Quarters at this post including plumbing, electric light wiring and fixtures. Information, blank forms for proposals, etc., furnished on application. U. S. reserves the right to reject or accept any or all bids, or any parts thereof. Envelopes containing proposals to be endorsed: "Proposals for Hospital Corps Sergeants' Quarters, to be opened September 15, 1908," and addressed to Captain H. J. Hirsch, Constructing Quartermaster.

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Consulting Forester

LEVEE WORK.

Greenville, Miss.

Sealed proposals will be received at the
office of the Board of Mississippi Levee
Commissioners, Greenville, Miss., up to 12
M., Monday, September 7, 1908, for the con-
struction of about 1,250,000 cubic yards of
embankment in the Mississippi Levee Dis-
trict.

Profiles, plans and specifications may be
seen and other information that bidders may
desire can be obtained at the office of the
Chief Engineer.

No bids will be considered unless accom-
panied by a forfeit of 3 per cent, and if ac-
cepted, good and sufficient security will be
required for the proper execution of the
work.

The right to accept or reject any or all
of the proposals or any part thereof is re-
served.

C. H. WEST, Chief Engineer.

RAILWAY WORK.

WANTED.

Contractor with team outfit to grade seven
miles of railroad, 75,000 to 80,000 yards of
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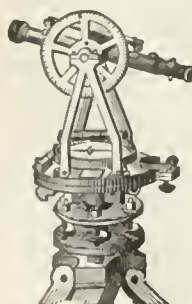


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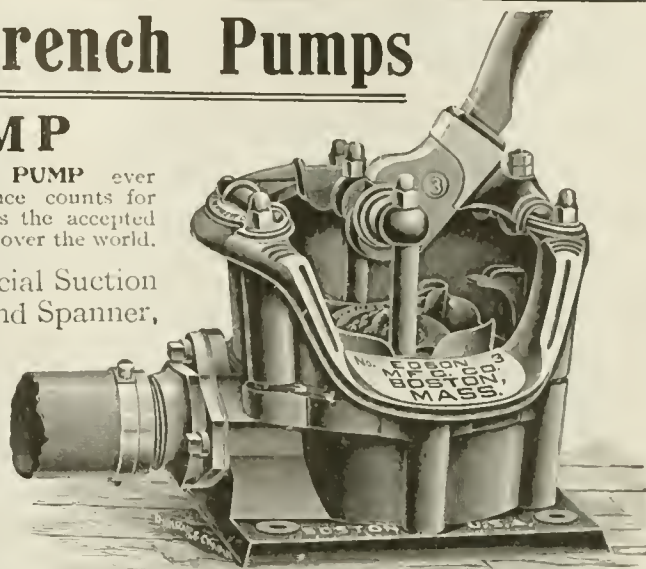
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OUTLET SEWER.

Peoria, Illinois.

Sealed bids for the construction of the North Peoria Sewer, West Section, to consist of a main brick and vitrified tile sewer and an outlet brick sewer, in accordance with an ordinance passed by the City Council of the City of Peoria, on the 7th day of May, 1907, and the plans, specifications and profiles now in the Office of the City Engineer of the City of Peoria, will be received before, and opened at two (2) o'clock p. m. on the 15th day of September, A. D. 1908, in Room 306, City Hall Building, Peoria, Ill.

The estimated cost of said sewer and outlet is estimated at \$234,586.10.

Bids for the whole of said improvement must be accompanied by a certified check or cash for at least ten per cent (10 per cent) of the bid, payable to the order of E. A. Furry, President of the Board.

Blank Proposals, copies of Contract and of Bond, as well as plans, specifications and profiles can be seen at the Office of the City Engineer, Room 308, City Hall Building, Peoria, Ill.

Work must be completed on or before May 1st, A. D. 1910.

The contractor is to be paid in bonds bearing five per cent (5 per cent) interest per annum, pursuant to the statute of the State of Illinois, governing Local Improvement, in so far as he is not paid in cash.

Bids must be made on blanks furnished by the undersigned.

BOARD OF LOCAL IMPROVEMENTS.

By E. A. Furry, President.

Isaac J. Levinson, Secretary.

SEWERS.

Vicksburg, Miss.

Sealed bids will be received by the Mayor and Board of Aldermen of Vicksburg, Miss., till 8 P. M., Sept. 7, 1908, for furnishing materials and constructing complete, a system of house sewers, approximating 30 miles of 8-inch to 27-inch pipe sewers, with 400 man-holes and 100 flush tanks. Deposit 3% of amount of bid. The right is reserved to reject any and all bids. For blank forms, specifications and other information, address Walter G. Kirkpatrick, civil engineer, Jackson, Miss. Plans and specifications are on file at the City Hall, Vicksburg, and the office of the engineer.

P. M. HARDING, Mayor.

PIPE SEWERS.

Carroll, Iowa.

The City of Carroll, Iowa, will receive sealed bids until September 8, 1908, at 8 o'clock p. m., for furnishing all of the material and labor necessary for the construction of about 1,240 feet of 10-inch and 13,700 feet of 8-inch sewers, and about 4,930 feet of 6-inch sub-drain, and appurtenances. Plans and specifications may be obtained from City Clerk.

J. A. DOUGHERTY, City Clerk.

PIPE LINE.

Morenci, Arizona.

Proposals will be received until 9 o'clock a. m., September 16, 1908, for grading and laying about twenty-five thousand (25,000) feet of ten-inch wrought steel pipe over rough country. The work will start about October 1st, and must be completed by January 1st, 1909. The contract will be let at a price per foot. The right is reserved to reject any or all bids, or to waive any informality in the bids received.

Information or specifications on application.

THE MORENCI WATER COMPANY,
C. P. Chester, Superintendent

PAVING.

Dublin, Ga.

Sealed proposals on blank forms furnished by the city and addressed to the Mayor and Board of Councilmen, Dublin, Ga., will be received until 8 o'clock p. m., September 3d, 1908, for furnishing all material and labor for the following work:

Approximately:

17,200 square yards of street paving (vitrified brick, wood block or bitulithic will be considered) with necessary granite curb as specified.

Each bid must be accompanied by a certified check, made payable to the Mayor, for twelve hundred (\$1,200) dollars.

The right is reserved to reject any or all bids.

Plans and specifications can be seen at the office of the City Clerk of Dublin, Ga., and specifications will be mailed upon application to the engineers.

W. S. PHILLIPS, Mayor
E. D. WHITE, JR., Clerk

H. S. JAUDON & GOSS, Engineers
Box 582, Savannah, Ga.

BRIDGE, TANKS, BUILDING.

Morenci, Arizona

Proposals will be received until 9 o'clock a. m., September 16th, 1908, for furnishing all labor and material and erecting:

One light steel truss bridge, 190 feet long

One steel frame corrugated iron power house building, 65 feet by 80 feet.

One steel oil tank, 50,000 gal. capacity.

Auxiliary water tank and miscellaneous steel work.

The work is to be let in one contract at a price per pound for each class of work. The designs are to be made, subject to the approval of the Morenci Water Company by the contractor after the contract is let. The right is reserved to reject any or all bids or to waive any informality in the bids received.

Information and specifications furnished on application.

THE MORENCI WATER COMPANY.

C. P. Chester, Superintendent

WATER-WORKS.

Holyrood, Kansas.

Sealed proposals will be received by the Mayor and the Council of the City of Holyrood, Kan., until 8 p. m., Sept. 8, 1908, for the construction of a system of water-works complete, and for any part thereof, for the water tower erected, and for all machinery, materials and supplies f. o. b. cars and delivered on the ground at site, and all in accordance with certain maps, plans and specifications therefor, which may be seen at the office of the City Clerk and of George Cadogan Morgan Engineer, 808 Royal Insurance Building, Chicago, Ill., on and after Aug. 20, 1908, where full particulars can be obtained.

Proposals must be accompanied by clearing house checks for 10 per cent of the amount thereof, made payable to said city as an evidence of good faith.

Proposals must be sealed and addressed to H. A. Stoltzberg, Mayor, and Council care of F. A. Wesely, City Clerk, Holyrood, Kan., and marked on envelope, "Proposal for Water-Works," or part bid upon, and must be delivered to the City Clerk at his office on or before the time stated above.

The City Council reserves the right to accept or reject any and all proposals.

F. A. WESELY
City Clerk

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MONON IND. July 16, 1908
Miracle Pressed Stone Co.
Minneapolis
Dear Sirs -
We wish you to ship us
C.D. by express 12" culvert tile
mold (8-ft length) quoted at
\$20.00 weight 70 lbs. We are
using the machine
& want to give yours a trial
& if they prove satisfactory
we may be able to do business
with you - kindly acknowledge
receipt of this & oblige
Yours very truly
The Monon Cement Tile Co.
Discount? By J. S. Sandy

This letter was written July 16, 1908; received July 18 and the mold shipped the same day. That the Miracle Mold need only be tried to win is shown by the following order received 3 days later:

Miracle Pressed Stone Co.,
Minneapolis, Minn.

Monon, Ind., July 21, 1908.

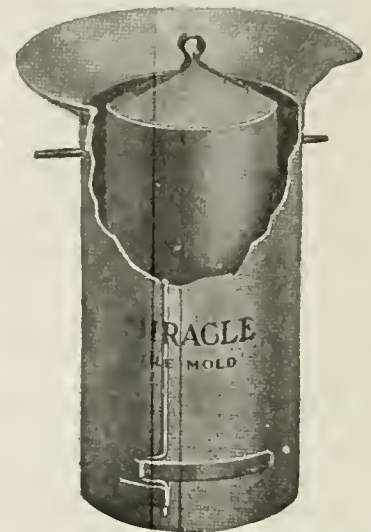
Dear Sirs:-

We are in receipt of 10" straight Tile Mold and have given same a trial with satisfactory results. Kindly send us by express one 12" straight Tile Mold complete.

Yours very truly,
The Monon Cement Tile Co.

We want you to have our 24-page Pipe Mold Catalog. Sent free. It gives valuable information on the business in general, including experience of people who have made successes, gives reports of thorough tests of cement tile made by Iowa State College, compared with clay tile. Shows New Miracle culvert molds; Miracle man-hole mold; how to make Y's and T's from standard pipe without extra tools, and other things of practical value.

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HOSPITAL BUILDING.

Fairview, Penna.

Sealed proposals for the construction of new buildings pertaining to the State Hospital for the Criminal Insane, for the Commonwealth of Pennsylvania, at Fairview, Wayne county, Pennsylvania, to be addressed to the Pennsylvania Commission to erect a Hospital for the Criminal Insane, will be received at the office of the commission, 608 Real Estate Trust Bldg., Philadelphia, until noon of Thursday, September 3, 1908, when and where the bids will be opened. Certified check for five thousand (\$5,000) dollars must accompany each bid.

Plans, specifications and form of proposals may be had on application at the office of J. C. M. Shirk, architect, 518 Philadelphia Bank Building, Philadelphia, Pa., by depositing the sum of two hundred (\$200) dollars, one hundred and ninety-five (\$195) dollars of which will be refunded upon return of the plans and specifications.

Bids from other than those engaged in the actual business and the general branches therein mentioned will not be entertained or considered.

The commission reserves the right to accept as a whole or in part, or reject any or all bids, as may be deemed best for the interests of the commonwealth.

HENRY F. WALTON, Chairman.

SEWAGE PUMP.

Memphis, Tenn.

Sealed proposals will be received at the office of the City Register, City Hall, Memphis, Tenn., until 12 o'clock noon, Thursday, September 10th, for one 20-inch centrifugal sewage pump, on bidder's specifications.

Information, plans, etc., can be had from J. H. WEATHERFORD, City Engineer.

STREET PAVING.

Cambridge, Ohio.

Sealed proposals will be received at the offices of the Board of Public Service of the City of Cambridge, Ohio, until Thursday, 12 o'clock noon, September 10th, 1908, for the grading, drainage, curbing and paving of sundry streets in said city, in accordance with the plans, profiles and specifications on file in the offices of the Board of Public Service and the Engineer of said city.

The quantities to be used in the comparison of proposals are approximately as follows:

Excavation, 16,010 cubic yards.
Brick paving, 28,296 square yards.
Curbing, straight, 16,603 lineal feet.
Curbing, 10 feet radius, 754 lineal feet.
Curbing, 5 feet radius, 535 lineal feet.
Protection curb, 1,155 lineal feet.
31 Catch Basins.
15 Manholes.

2,560 lineal feet of 15-inch sewer pipe.
900 lineal feet of 12-inch sewer pipe.
3,000 lineal feet of 4-inch tiling.

Each proposal must be made on blank forms to be furnished by the Engineer of said city, and must be accompanied by a certified check for \$1,500 drawn in favor of Sarah Rainey, secretary, WITHOUT CONDITIONS, as liquidated damages, that the bidder will enter into contract within 10 days if awarded the work.

The Board of Public Service reserves the right to reject any and all bids, or to accept the proposal deemed by them to be for the best interests of the city. Plans and profiles may be seen, and copies of specifications, blank proposals, form of contract, etc., obtained at the office of the Engineer of said city.

A. J. HALL,

President of the Board of Public Service.

SARAH RAINEY, Secretary.

O. M. HOGE, City Engineer.

CONCRETE DAM.

Chambersburg, Pa.

Sealed proposals will be received by the Clerk to the Town Council of the Borough of Chambersburg, at his office in the Market House, Chambersburg, Pa., until 6 p. m. Monday, the 7th day of September, A. D. 1908, for the furnishing and supplying of all labor, hauling and materials necessary for the proper construction of a concrete dam and side walls and the supplying and building therein of steel or wrought iron head gates, together with the removing of all trees, stumps, roots, gravel, earth, stones and materials not needed for filling, to such places as may be designated by the person, officer or committee in charge of said work, for the Borough of Chambersburg, Pa., at their Siloam Pumping Station, in accordance with blue prints, plans and specifications accompanying same on file at the office of said Clerk, Chambersburg, Pa.

Copies of the plans and specifications aforementioned may be seen at the office of said Clerk.

The right is reserved to reject any and all bids.

E. V. FREY, Clerk.

BRICK PAVING.

Kirksville, Mo.

Sealed proposals will be received up to 8 p. m., September 7, 1908, by J. C. Carothers, City Clerk, for construction of approximately 16,000 sq. yds. vitrified brick pavement and 6,400 lineal feet of concrete curb.

Plans and specifications may be seen at the office of the City Clerk. Bids must be accompanied by a certified check in the sum of at least three per cent of the bid. The Council reserves the right to reject any or all bids.

H. SHELBY, Mayor.

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for Civil Engineers and Contractors.

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ADVERTISING RATES sent on application.

Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

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Another Specification for Embankments.

In our issue of August 19 we commented upon a set of specifications for a railroad embankment. We quote the following clause from another set of specifications for railroad construction:

"Embankments shall be made of suitable materials, to be judged of by the engineer and in accordance with his instructions, either by dumping from grade, or in layers of such thickness as he may direct; no large stones shall be allowed within a depth of at least two feet below sub-grade, and the best materials must in all cases be reserved for finishing and dressing the surface; the contractor shall be required to carry the embankments to such height above sub-grade and to such increased widths as the engineer may deem a necessary provision for shrinkage, compression, washing, drainage and settlement, and said embankments must be maintained to their proper height, width and shape until the entire work under this contract is finally accepted by the engineer. Whenever the embankment is made from side ditches, such ditching and crest of the slopes thereof shall in no case approach within six feet, nor within double the depth of the ditch, to the foot of the embankment slopes, always leaving room for a double track on one side. The width of berm left at the foot of the slopes shall in all cases be such as the engineer may direct. No soft mud or muck or perishable materials shall be allowed to enter into the composition of the embankments. Whenever new water courses or channels for rivers or streams are required to be formed, they shall be put at such distance from the foot of the slope as the engineer may direct. The filling in the rear of abutments and retaining walls shall be specially deposited in 12 in. layers, well rammed and inclined away from the structure, as directed by the engineer. Suitable porous materials shall be selected for such back filling."

This clause has much to commend it, as in most of the sentences the details of the work are specifically set forth. This is as it should be, as then there can be no chance for dispute between the contractor and the engineer. Then, too, knowing beforehand what is to be expected of him, the contractor will name a lower price for the work.

However, in three places the term "as the engineer may direct," or a similar one, is used. This phrase should be eliminated from specifications wherever possible. Where this phrase is used as to the shrinkage of materials, certain limits of percentages of shrinkage for the different materials could be substituted, or it could be stated that stakes and points would be given the contractor to guide him in the work. Likewise a minimum width of berm could have been stated in the second case. In the last case the words "as directed by the

engineer" could be omitted, as the instructions regarding the work are complete without it.

What Load Will a Concrete Pile Sustain.

In the aggregate, a large number of tests of the bearing power of wooden piles can be found in print, but there is precious little information of the same kind concerning concrete piles. This, of course, is to be expected because of the relative youth of the concrete pile industry. In view of the fact that there are several firms that make a specialty of concrete pile construction, each claiming superiority, it would seem practicable for them to arrange some competitive tests which would demonstrate not only their relative merits but the absolute bearing power of their respective kinds of piles in different soils. At the same time and place, wooden piles should be driven and tested by loading.

One concrete pile firm claims that one of their piles will sustain two to three times the load that a wooden pile will carry. This is very important if true. But where is the evidence?

Another firm states that the corrugations or fluting in their concrete piles greatly increase the bearing power, and that no other pile of any sort can compare with theirs in supporting power. The argument is good, but engineers would like comparative tests to prove the statement.

Still another firm states that their process of concrete pile construction gives the greatest bearing power, because the concrete is cemented to the earth. This sounds reasonable, too, but what comparative tests have proved it?

In view of such conflicting claims and of the steadily growing importance of the concrete pile industry, engineers would welcome a series of competitive tests of different kinds of concrete piles, especially if the tests were made under the direction of some disinterested engineer or committee of engineers.

On Sept. 6 Leon Delagrang, president of the Aviation Club of France, established a new world's record with his aeroplane at Issy, both for length and duration of flight. M. Delagrang remained in the air for 29 minutes 54.4-5 seconds and circled the field 15½ times, covering a distance of 24,727 meters, or about 15¼ miles. He thus beat the longest time flight previously made, that by Henry Farman, in July, by 9 minutes 34.1-5 seconds, and exceeded the distance covered by Wilbur Wright on Sept. 5 by 1¼ miles.

A lake at Bassein, Burma, owned by the government, stocked with varieties of table fish, brings an annual income of over \$6,000. The Burma government is taking steps to utilize Victoria Lake in the same way.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

The Importance of Sand in Concrete Construction.*

BY J. S. LEONARD.

The important part that sand plays in concrete work is not generally recognized, and even among contractors and engineers who have at some time experienced trouble directly traceable to the sand used, we find a tendency to depend too much at times upon superficial examination.

One has only to see concrete, of proper proportions and good materials, such as 1 cement to 3 sand and 5 or 6 stone, mixed, to marvel at the wonderful binding qualities of the cement when he observes this mixture at the end of a few days; he will note, however, that the cement must be

strength with the probability of injury, serious loss or complete failure?

In making comparisons between tests of natural sand and the laboratory sand (crushed quartz or the present standard Ottawa sand) it must be kept in mind that a clean, sound and well graded natural sand will give higher tensile results than the laboratory sands, and of the latter the Ottawa sand is superior to the crushed quartz; due allowance must, therefore, be made for the above facts in the tabulations following. The high value of crushed stone dust as a mortar ingredient will be particularly noted.

The results in Table I are relative and comparable, the same sample of cement being used throughout. None of the natu-

TABLE I.

Character of Sand.	No. 8.	Sieve Test-residue. Per cent.			Cement Mortar. Comparative Tensile Test Portland 2 to 1, 7 days. Crushed Quartz.	
		No. 30.	No. 100.	Passing No. 100.	2 to 1, 7 days. Sand.	7 days. Crushed Quartz.
Crushed quartz	0.0	10.0	60.0	0.0	.....	.....
Selected natural	14.3	57.1	26.4	1.3	351 lbs.	266 lbs.
Granite dust	22.6	32.1	25.1	20.1	422 lbs.	248 lbs.
Bank sand	22.0	43.4	25.8	8.1	111 lbs.	248 lbs.
Bank sand	7.5	48.6	26.1	7.3	273 lbs.	248 lbs.
Bank sand	21.2	42.8	22.6	6.9	159 lbs.	248 lbs.
Bank sand	17.5	38.8	32.5	10.6	251 lbs.	248 lbs.
Bank sand	17.6	31.0	37.1	10.7	180 lbs.	248 lbs.
Bank sand	24.7	35.0	28.3	11.5	194 lbs.	248 lbs.
Bank sand	15.6	48.8	28.3	7.0	253 lbs.	248 lbs.
Bank sand	8.8	33.7	35.1	22.1	283 lbs.	248 lbs.

Note.—The residue on No. 8 screen not used in the mortar test. All percentages and proportions were determined by weight.

spread out pretty thin to fill the interstices of the sand and coat the surfaces of the individual grains three times in volume the amount of cement used. If the sand, however, be poor by reason of its geologic origin, mineral composition or decomposition, or because of excessive fineness, or its content of fine material of a non-siliceous nature, then it is useless to expect good results of such proportions as 3 of sand to 1 of cement, and only careful analysis and test of the sand will enable us to judge as to whether it should be used at all, and, if so, in what proportions to attain the desired results within the required working limits of 7 or 28 days.

It may be, and some cases should be cited, that some poor sands would, in time, produce a sufficiently strong mortar if properly mixed with the cement; but do you know this of the sand in question? Can you afford to wait for the necessary results? Will your structure in the meanwhile be stressed beyond its required

strength with the probability of injury, serious loss or complete failure?

The gradation of sand, as determined by the sieve tests, is not, alone, an index of its value as a mortar ingredient, and unless accompanied by tensile tests of the mortar this determination is often misleading.

Bank sand, 26 samples, average 7 days (3 to 1)..... 168 lbs.
Standard sand, 23 tests to compare 246 lbs.
Bank sand, 21 samples, average 28 days (3 to 1)..... 261 lbs.
Standard sand, 19 tests to compare 352 lbs.
Bank sand—gain in strength, 7 to 28 days (average)..... 55 per cent.
Standard sand—gain in strength, 7 to 28 days (average) 12 per cent.

Note.—The standard sand used for comparative tests was the Ottawa sand passing the No. 20 and held on the No. 30 sieve, excepting samples Nos. 9 and 10,

in which crushed quartz was used. The samples of bank sand represent commercial sands used extensively in New England.

An experienced and trained observer can generally pass upon the stability of sand from the standard of fineness, but tensile or compressive tests will be required to fix its real value.

There is as much or even more commercial advantage to vendors of sand in showing comparative tests of their product in mortars as to cement salesmen in following this time-honored custom.

Dredged Sand.—Screen analyses of samples A and B are given as representing the approximate extreme variations in dredged sands extensively used in and near Boston. No tensile results given.

Comparison: Each sample of bank sand may be compared with the standard sand results shown opposite, the same cement being used in each; but the same cement was not used throughout the series of twenty-six samples. A standard high-grade Portland cement was used in every case.

For the results shown in Table II, the association is indebted to Messrs. Sherman & Edwards, Chemists and Cement Testers, Boston, Mass.

The general tendency in all reinforced concrete construction in the best practice is toward richer mixtures, particularly for column, beam and slab construction. The economy and logic of this is readily seen.

1st. It makes possible the more economic handling of forms.

2d. It is a safeguard against the dangers of average poor sand.

3d. It means added strength and insures closer and more perfect contact with the steel.

4th. It reduces to a minimum the personal equation in mixing and placing the concrete, the latter operation sometimes called "unmixing."

5th. It means better fireproofing in that the aggregate is better covered and protected.

6th. It is denser, stronger and more waterproof.

7th. The difference in cost per cubic yard of concrete is nominal and much less than appears by reason of the advantages under Nos. 1 to 6.

The actual difference in cost of cement alone, per cubic yard of concrete, is given below, the assumed cost of cement being \$1.50 per barrel net:

Proportions.	Cement required. Bbls.	Cost cement Per cu. yd.
1:1½:3	1.90	\$2.85
1:2:4	2.48	2.22
1:2½:4	1.38	2.07
1:3:5	1.11	1.71
1:3:6	1.02	1.53

We are all reminded in this connection of the small percentage cement bears to the total cost of the completed work; in

*EXTRACT from a paper read before the National Cement Users' Association.

other words, if reinforced concrete in building construction could be figured at as low an average cost as \$20 per cubic yard, the percentage cost of cement would be as follows for the several proportions given:

Proportions.	Cost of cement —Percent- age of total. Per cent.
1:1½:3	14
1:2:4	11
1:2½:4	10
1:3:5	8½
1:3:6	7½

When we consider the many attending

Methods and Cost of Constructing Concrete Silos.

One of the most popular uses of concrete on the farm is for the construction of silos. Owing largely probably to the fact that the work is done by the farm help with possibly some assistance from the local carpenter and mason few data are made public either on the methods of construction or on the cost of silo building. We give therefore the following data taken from letters published in "Hoard's Dairyman" for June 19, 1908, which, while they are not complete, give information of value.

One correspondent gives the cost of a

have done all the work. The top of the silo walls are not given but assuming bottom and walls to have averaged 6 ins. thick there were about 18 cu. yds. of concrete in the structure assuming the volume of the door openings to equal the volume of the floor. This gives a cost per cubic yard of concrete of \$8.60.

A second correspondent describes the construction of his silo as follows:

"My silo is 16 ft. in diameter, inside measurement, 8 ft. in the ground and 32 ft. above. Underground, the wall is 8 ins. thick; above ground, 6 ins. Wire ropes made of 4 strands of No. 12 smooth wire were imbedded in the wall every 18 ins.

TABLE II.

	Sieve Test, per cent. passing.							Comparative Tensile Results 1 cement to 3 sand.			
	No. 100.	No. 50.	No. 30.	No. 20.	No. 16.	No. 10.	No. 8.	Bank Sand as per analysis.	Standard Sand to compare.	7 days.	28 days.
A Dredged sand	9.6	6.2	13.4	16.7	19.5	23.5	30.5	48.5	...	...	...
B Dredged sand	5.5	31.2	67.5	82.4	88.2	92.4	96.3	99.2	...	...	...
1 Bank sand	12.5	42.2	...	...	...	...	...	...	155	281	356
2 Bank sand	...	15.0	...	...	...	...	...	...	121	251	321
3 Bank sand	5.1	35.8	...	97.0	100	...	...	...	137	242	186
4 Bank sand	5.0	15.2	...	57.2	63.1	...	...	...	226	389	186
5 Bank sand	9.0	43.0	71.3	84.4	89.3	91.0	92.5	96.2	238	349	...
6 Bank sand	...	...	...	...	...	...	...	...	11	121	230
7 Bank sand	...	...	...	...	...	...	...	...	28	140	267
8 Bank sand	22.4	28.8	33.9	41.4	50.3	58.1	66.3	78.1	267	...	...
9 Bank sand	25.8	54.1	70.5	81.4	87.6	90.1	92.8	95.5	197	308	...
10 Bank sand	4.5	25.4	54.8	80.3	95.7	98.7	99.3	100	120	145	...
11 Bank sand	2.5	8.7	19.5	35.0	57.8	69.1	80.1	89.7	311	456	...
12 Bank sand	10.5	42.2	63.3	75.0	82.5	85.0	87.3	90.0	194	...	...
13 Bank sand	10.5	22.9	30.9	41.7	51.0	62.1	68.0	77.3	113	261	...
14 Bank sand	0.0	6.0	30.6	40.0	56.0	61.0	67.0	72.8	108	...	...
15 Bank sand, loamy	5.4	22.1	52.4	72.3	83.7	88.1	90.7	94.0	93	123	...
16 Bank sand, loamy	5.4	22.1	52.4	72.3	83.7	88.1	90.7	94.0	109	154	...
17 Considerable mica	2.5	31.8	77.0	96.9	99.5	99.8	100	...	105	160	...
18 Beach sand	35.3	99.8	100	...	...	...	...	...	151	...	...
19 Large number small shells	16.0	92.4	96.8	99.5	100	...	...	...	127	...	...
20 Bank sand	2.0	5.0	16.2	38.7	66.2	78.2	85.0	92.5	169	238	...
21 Bank sand	5.4	25.9	18.6	65.6	79.3	84.3	88.6	93.0	122	166	...
22 Bank sand	3.0	13.8	34.3	58.4	76.6	83.0	87.8	94.7	167	229	...
23 Bank sand	5.0	48.5	81.3	93.4	97.5	98.0	98.6	99.5	194	275	...
24 Bank sand	1.0	4.8	14.3	30.0	48.8	57.6	67.5	79.3	310	401	...
25 Bank sand	6.6	11.3	18.7	33.5	51.7	62.0	70.0	83.7	309	347	...
26 Bank sand	9.7	20.5	32.0	42.5	53.5	60.7	66.7	71.5	287	439	...

advantages of the richer mixtures, is there any reason—financial, structural or sentimental—why we should not use them?

The recently promulgated law for the construction of new railways in Italy provides for the expenditure of \$107,000,000 during the next 16 years. Of this sum the two largest appropriations (of \$29,000,000 each) are for the improvement of the direct lines between Genoa and Tortona (which will shorten by 16 miles the distance from Milan to Genoa) and between Florence and Bologna. The direct line between Naples and Rome receives an appropriation of \$17,000,000. The improvement of communications in the southern provinces is provided for as follows: Sicily, \$5,800,000; Basilicata, \$17,300,000; Calabria, \$1,350,000. An amount of \$5,600,000 is given to the line from Archangelo to Urbino, \$1,737,000 to the Piedmontese roads, and, finally, a sum of \$965,000 has been put at the disposition of the government for the study of railroad problems and of the new lines most needed by the country as a whole.

The quarterly meeting of the Association of American Portland Cement Manufacturers is to be held Sept. 14, 15 and 16, at Hotel Pontchartrain, Detroit, Mich.

concrete silo 10 ft. in diameter and 31 ft. deep—15 ft. in ground and 16 ft. above ground—as follows:

Materials.	Cost.
90 bags Portland cement at 50 cts.	
for wall	\$45.00
2 bags Portland cement at 50 cts.	
for brush coat	1.00
Bolts	1.00
No. 3 wire for reinforcing	2.00
20 cu. yds. gravel	3.20
½ material for form	6.40
Roof, door frames and doors	9.70

Total materials \$68.30

Only one-half the cost of forms is charged up because the same forms were used in constructing a second silo. There were 11 days labor on the work divided as follows:

30 days building wall at \$2.....	\$60.00
3 days making one-half form at \$3.50 10.50	
8 days all other work at \$2.....	16.00

Total labor \$86.50

In this tabulation the number of days labor is as given by the correspondent; the wages have been assumed by us and totals figured from them. As a matter of fact the farmer himself and a neighbor, with whom he exchanged work appear to

Each of these ropes goes round the silo near the outer edge. The door frames were made 1 ft., 8 ins. wide by 2 ft. in height, of 2x6-in. stuff, and set in as the wall went up.

The excavation was dug 17 ft. 4 ins. in diameter and perfectly round, and the bank cut smooth and perpendicular, and the bottom made level. From the exact center of the excavation, a circle was drawn 16 ft. in diameter, which left just 8 ins. between it and the bank all around. On the inside, close up to this circle, 2x1 studding, 2 ft. apart, were perpendicularly placed and braced to a stud set perpendicularly in the exact center of the silo. One-inch boards 6 ins. wide were used to brace each stud, both at the top and bottom, to the center stud. On the outside of this circle of studding, next the bank, ½ in. boards, 6 ins. wide, were nailed with small shingle nails. These could be easily bent to the form of the circle. I used a spirit level to get them at a true level on the ground. When this was boarded up solid for about 2 ft., the building of the wall began, and as needed more siding was nailed on, the bank being the outside form until the surface of the ground was reached. My studs were 12 ft. long. When the top of these were reached, other studs were spiked on, lapped 1 ft.

and braced to a center stud as before. When the top of the second course was reached, the lower studs were pried off, and they and the $\frac{1}{2}$ -in. stuff used again above. The center stud should not be taken out.

When the top of the excavation was reached, two sheet iron forms were used, made of No. 20 galvanized iron, each 18 ins. wide and about 55 ft. long, so as to reach quite around the silo. On the ends of these forms, angle irons were fastened; one iron being set about 1 ft. from the end to allow for that much lap. Two $\frac{5}{8}$ x8-in. bolts, with thread cut on one end go through the angle iron, by means of which, the form was tightened. To keep these sheet iron forms just 6 ins. from the inner form all the way round, pieces of 2x6-in. studding 1 ft. long were placed every 2 ft. inside the sheet iron form and just opposite the studding of the inside form. These pieces were slipped up as the form was filled. When the first form was filled, the other was placed on top, and likewise when it was full, the one beneath was loosed and put on top. The cement will set fast enough to allow of the filling of two forms a day. Three or four lifts made of strap iron, with a hand hold turned on one end and the other end bent to a right angle for $\frac{1}{2}$ in., were convenient for lifting the forms. Great care should be taken to start the forms level; a good, true spirit level should be used.

Portland cement, clean sand and broken limestone were the ingredients of the concrete. The sand and cement were mixed dry in the proportion of 1 of cement to $2\frac{1}{2}$ of sand for the lower one-third of the silo and 1 of cement to 3 of sand for the rest of the way. Two mortar boxes were used so that while the mortar was being taken from one, the mixing was proceeding in the other. The mortar was mixed rather thin and poured into the forms to the depth of 3 or 4 ins. and at once all the broken rock tamped in that the mortar would hold, care being taken that all the rock spaces were filled.

When the work was interrupted, so that the cement would be likely to set before building could be resumed, the upper surface was left rough with partially exposed rock, so that when the next cement was poured in, it would adhere firmly. The broken rocks were thoroughly wet before being put in the wall. Bolts $\frac{1}{2}$ by 6 were imbedded in the top of the wall all the way around and standing out $2\frac{1}{2}$ ins. in order to fasten the roof plate. When the wall was completed the inside was made smooth with a coat of cement, as a cistern is finished. The mortar should be made 1 part of cement to 2 parts of fine, well sifted sand.

The amount of material used and the cost was as follows:

54 barrels of cement at \$1.60.....	\$ 86.40
23 cubic yards of sand.....	25.00
20 pounds of wire	2.00
2 dozen bolts	1.00

100 feet of lumber for frames and doors	2.00
2 galvanized sheet iron forms....	18.00

Total\$134.40

The lumber used for staging and for inside form was used for other purposes. The roof has not yet been put on, and although we have had an excessively wet fall and winter, the silage has kept beautifully. With the material all on the ground, four men could build the silo in about 14 days."

Figuring the wages of labor at \$2 per day the cost of the silo was as follows:

Materials as per above table.....	\$134.40
Labor, 4 men 14 days at \$2.....	112.00

Total\$246.40

There are about 33 cu. yds of concrete in this silo, which makes the cost about \$7.46 per cubic yard, with all materials on the ground.

As door construction is one of the details that causes some trouble in concrete silo construction we take the following description of another correspondent:

"I have four doors, 20 ins. by 24 ins. above the ground, the lower door being even with the ground, and the upper one 2 ft. from the top of the silo. The openings have no casings. When building the silo we set in a wood frame made of $1\frac{1}{2}$ x12-in. lumber, the outside dimensions of which was 20x24 ins., the desired size of the door. This frame was not nailed together, simply held together by the use of cleats which could be easily removed when the concrete had become hard enough to remove the frame. Completely around on the outside of the inner edge of the frame were fastened pieces of smooth lumber $1\frac{3}{4}$ x2 $\frac{3}{4}$ ins.

"This device made an offset, or rabbet, in the door jamb, against which the door presses when in position. The dimensions of the rabbet, therefore, are $23\frac{1}{2}$ x27 $\frac{1}{2}$ ins. in depth at the center of the door, top and bottom, deepening to about $2\frac{1}{2}$ ins. at the outer edges on account of the curve of the circle on inside of the silo. From clear surfaced redwood, $1\frac{3}{4}$ ins. thick and 24 ins. in width, we first cut a door to fit the rabbet, allowing the grain of the lumber to run lengthwise of the door. Then we cut a piece from the same material the size of the door proper, 20x24 ins., but turned the grain of the lumber crosswise of the door. This piece was bolted to the piece set in the rabbet, thus making a strong rabbetted door.

"In the center of the door, about 4 ins. from the top and bottom we inserted bolts $\frac{1}{2}$ in. by 14 ins., threaded end out. These bolts project through pieces of 2x4 scantling 24 ins. in length, which are placed across the outside of the opening and allow the doors to be drawn tight into the rabbetted section of the opening by simply drawing the nuts up tight with a wrench. Before placing the doors in position, we made a gasket of three thicknesses of patent rubber roofing, which lies in the rabbetted section of the opening and renders

the door air-tight. We used wood fibre plaster to shape the inside of the doors to the curve of the silo, first driving thickly into the surface of the door a large number of shingle nails, the heads of which acted as clinchers for the plaster."

The Mill Rock water tower, erected by the New Haven Water Co. at New Haven, Conn., is 50 ft. in diameter and 25 ft. in clear height. It is located on top of a rocky ledge about 200 ft. above the road. A narrow gauge incline cableway was built, having a grade of about 50 per cent in the steepest place, and running from the concrete plant at the base of the rock to the water tower. All concrete was mixed at the bottom. The track ran below the mixing plant, which was set well up in the air with large hoppers for all materials. A one-yard Smith concrete mixer was used. The buckets, mounted on small cars built up for the grade, were run under the mixer, loaded, and hauled to the top by a two-drum Lidgerwood hoisting engine. At the top, two stiff-leg derricks, set so as to command practically all sides of the tower, lifted the concrete to place. For the walls a three-sided box was built, set on wooden rollers, and the buckets dumped into this. In this way a cubic yard of soft concrete was placed in the walls easily and quickly and the box kept traveling along the walls at a good speed. A wall section would be taken off and reset above in two days. It would take one day to fill it. The old surfaces throughout the work, where new concrete set on old, were picked and then thoroughly cleaned with a steam jet. Great pains were taken to have old surfaces well cleaned and to have all concrete thoroughly spaded. The concrete above the foundation was mixed in the proportion of 1-2-4. Vulcanite cement was used, crushed trap rock passing a $1\frac{1}{2}$ -in. hole, and sand having a uniformity coefficient of about 3.5. The tower has been filled for several weeks and has proved practically tight. On the southerly side for a short distance there appears some seepage at the joints. This is sufficient to dampen the surface of the concrete for a width of about 3 ins. Elsewhere the surface appears dry.

The railroad from Damascus to Mecca in Turkey which has been under construction for eight years, is now open to Medina, and there remains but 200 more miles of track laying before it reaches Mecca.

Reports of 34 carservice associations, covering practically the entire territory of the United States, with a total of 2,177,227 cars handled during July, 1908, indicates a gain over the figures reported by the same associations for any of the preceding months of the current year, with the single exception of January. The month's totals are, however, below the total of 2,634,601 cars reported for July, 1907, and of 2,357,930 cars reported for July, 1906.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Drilling Holes With a Well Drilling Machine.

In this article we give the cost of drilling holes through rock with a well-drilling machine. Holes Nos. 1 and 2 were holes from which cores were taken, being put down through limestone at Paris, Ky., for the Blue Grass Mining and Development Co. For these two holes a Cyclone steam four-core drill, class E 1, was used, taking a 3¼-in. core. This drill will take cores of 2¼, 3¼ and 4½ ins., to a depth of 300 ft. It is the lightest four-core drill made by the Cyclone Co., of Orroville, Ohio. Equipped ready for work, it is sold for less than \$1,000, but for our purpose of estimating depreciation and interest on the machine we will consider the price as \$1,000, as this figure will cover the freight and other incidental expenses of buying the machine. This machine can be operated by a drill runner and one assistant.

Hole No. 1.—This hole was entirely in limestone and was drilled to a depth of 104 ft. in 50 hrs. actual time of running the machine; the average rate of drilling per hour was 2 ft. 1 in. The men worked more than 50 hrs., the actual time they worked being charged against the hole. The cost was:

Moving drill	\$ 3.50
Coal	4.85
Water	3.00
Driller, 60 hrs. @ \$0.50.....	30.00
Helper, 66 hrs. @ \$0.15.....	9.90
Supplies, shot and bits.....	5.00
Depreciation, repairs and interest per day assumed at \$1.50.....	9.00
	\$64.25

This gives a cost per lineal foot of hole for each item as follows:

Moving drill	\$0.03
Coal	.05
Water	.03
Labor	.38
Supplies	.05
Depreciation, repairs and interest.....	.08
	Total.....\$0.62

Hole No. 2.—This hole was 158 ft. through limestone, 80 hrs. being consumed in drilling it. This meant a rate per hour of about 2 ft. The total cost of the hole was as follows:

Moving drill	\$ 3.75
Coal	6.00
Water	4.00
Supplies, shot and bits.....	10.00
Driller, 80 hrs. @ \$0.50.....	40.00
Helper, 88 hrs. @ \$0.15.....	13.20

Depreciation, repairs and interest, per day assumed at \$1.50.....	12.00
	Total.....\$88.95

This gives a cost per lineal foot of hole for each item as follows:

Moving drill	\$0.02
Coal	.04
Water	.03
Labor	.34
Supplies	.06
Depreciation, repairs and interest.....	.08
	Total.....\$0.57

Holes Nos. 4 and 5 were drilled with cable tools, a No. 4 Cyclone drill being used for putting down a 5-in. hole. The work was done near Arritts, Va., for the Low Moor Iron Co. The No. 4 drill is a standard well-drilling machine, and will sink a hole to a depth of 500 ft. It has an 8-h.p. boiler and a 7-h.p. engine, mounted on traction wheels, weighing in all over 6,000 lbs. This machine can also be rigged to take cores. Depreciation, repairs and interest on it per day will be about the same as for the other drill. Two men operate it.

Hole No. 3.—This hole was drilled through the following materials:

Clay	7 ft.
Shale	113 ft.
Cap rock (disintegrated).....	8 ft.
Sandstone	14 ft.
	Total.....142 ft.

The time consumed in drilling this was 32 hrs., making a rate of 4 ft. 5 ins. per hour. The cost of the work was as follows:

Coal	\$ 4.00
Water	2.40
Driller, 40 hrs. @ \$0.20.....	8.00
Helper, 40 hrs. @ \$0.15.....	6.00
Depreciation, repairs and interest per day, assumed at \$1.50.....	6.00
	Total.....\$26.40

This includes moving the machine. The cost per lineal ft. for each item was:

Coal	\$0.03
Water	.02
Labor	.10
Depreciation, repairs and interest.....	.04
	Total.....\$0.19

Hole No. 4.—This hole was 67 ft. deep, being drilled through the following materials:

Shale	25 ft.
Cap rock	2 ft.
Ore	10 ft.
Sandstone	16 ft.

Flint	9 ft.
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Total.....67 ft.

Thirteen hours were consumed in drilling this hole, making a rate of progress of 5 ft. and 1 in. per hour. The cost of the work was:

Coal	\$1.00
Water	.30
Driller, 20 hrs. @ \$0.20.....	4.00
Helper, 20 hrs. @ \$0.15.....	3.00
Depreciation, repairs and interest, per day \$1.50.....	3.00
	Total.....\$11.30

This gives a detail cost per lineal foot of the following:

Coal	\$0.015
Water	0.005
Labor	0.100
Depreciation, repairs and interest.....	0.010
	Total.....\$0.160

All these holes, it will be noticed, were through soft rock, but the costs for the work are very reasonable.

Some Records and Comments on the Use of a Scraper Bucket Excavator.

In our issue Aug. 5, in describing the building of a sewer through quicksand at Gary, Ind., it was stated that in excavating the trench a Page & Schnable drag scraper bucket was used in excavating to a depth of 6 or 8 ft. We have been furnished some additional information regarding the operation of this bucket.

The bucket was of 2 cu. yds. capacity, being operated on a 58-ft. boom with the usual cable and chain attachments. The derrick house worked away from the excavation. The machine was not used to its full capacity, but excavated about 60 ft. of trench per day, just enough to keep ahead of the other forces which were arranged to complete 60 lin. ft. of sewer per 9 hr. day. The average swing made by the bucket was 90 degrees. In turning the bucket in its various operations, it was found that the average time for each motion of the bucket was as follows:

Swinging from embankment.....	5 secs
Lowering to trench.....	5 secs
Digging	15 secs
Hoisting full bucket.....	5 secs
Swinging to embankment.....	5 secs
Dumping	5 secs
	Total average time.....40 secs.

Thus 30 per cent of the time of operation is consumed in digging. The machine working to its full capacity, would however make the entire operation in less time, and the lowering of the bucket into the trench could be done as the swing from the embankment is made. At Gary, from 400 to 600 cu. yds. per day, place measurement, were excavated by the bucket. This meant an actual time for digging of 3 to 4 hrs. The rest of the time was con-

sumed in moving the machine ahead, which was over swampy ground at Gary, necessitating the placing of some of the excavated material ahead of the machine, which was readily done by swinging the machine through an angle of 180 degrees.

One day at Gary, in order to keep ahead of the sewer work, the Page bucket, excavated 850 cu. yds. Even with this record the machine was actually digging 5 hrs. out of the 9 hrs. worked. It must be remembered that the bucket was dumped on the side of the trench and not into wagons or cars, or some time would have been consumed waiting on the vehicles. Nor was it necessary to clean up on the sides of the trench.

In operating Page buckets on the New York State Barge Canal, where a number are being used, the excavation work being heavy and long booms being used, a machine does work for some hours in one position before being moved. In swinging the boom, the bucket drops considerable dirt on the slopes and the berm between the slopes and the waste bank and all of this material has to be cleaned up; that is, handled a second time by the bucket. This consumes considerable time, yet, even with this extra work, the machine has been found economical, and the contractors using them, state that they are one of the best excavating machines for canal construction on the market. Enough water is purposely let into the pit to make the material a little sloppy, as it is found that the bucket loads and empties itself much easier than when it is dry.

These buckets for earth excavation have been on the market for some years, but it has only been within the last few years that they have had any extensive use, and they are demonstrating that they can be used for many classes of excavation. We shall be pleased to publish records of work done by these buckets if engineers and contractors who are using them will furnish us with such data.

The first barracks building to be constructed of reinforced concrete for the use of enlisted men of the U. S. army will be erected at Fort Howard, Md. Work on the structure will begin before winter. The building will be of the newest type of barracks, the plans having been approved and adopted by the War Department. Similar barracks will be constructed in other army posts, but so far the only building of this type is said to be a dormitory structure for the use of the cadets at West Point.

The third annual meeting of the Lakes-to-the-Gulf Deep Waterway Association will be held in the Auditorium in Chicago, Ill., Oct. 7-9. The afternoon of Oct. 7 has been set aside for a trip to Lockport. New officers will be elected at this meeting at which 3,000 delegates are expected to be in attendance.

Drilling vs. Shaft Sinking.*

BY WILLIAM R. WADE,†

The Azure Mining Co. owns and operates in Burro mountains, New Mexico, the largest turquoise mine in the world. On the property is an open cut 750 ft. long, 60 ft. wide at the bottom, 150 ft. wide at the top and 80 ft. deep at the highest point, averaging around 60 ft. This mine also has over three miles of drifts, crosscuts, raises and shafts, having five different levels. Very large stopes have been mined out below the open cut. At present the turquoise production is small, as the company has turned its attention to copper.

There are two classes of copper deposits in these mountains, one fissure veins of the replacement type in granite and along con-

The Azure Co. has developed one of these fissure veins with a 100 ft. shaft, and decided to explore its tracts of monzonite porphyry and other lands. We decided that as the ore bodies in the porphyry generally dipped less than 15 degrees and were of large extent, a drill would be the best method, both as to speed and economy for discovery of ore and determining whether it would pay to sink a shaft to further develop it. A good shaft of two compartments, 300 ft. deep, costs all told around \$15,000, and a thousand feet of drilling and crosscutting from this shaft would bring the expense close to \$30,000. If this shaft has a crosscut from its bottom 500 ft. each way it would develop 1,000 ft. of ground. Now a row of drill holes placed 150 ft.



Cyclone Combination Core Drill at Work.

tact lines of granite porphyry, and the second and more important class, which are lenses of secondarily enriched ore in the monzonite porphyry. These lenses are low grade character ore, averaging between 2 and 3 per cent copper, and practically barren of gold or silver. The ore, however, is free from arsenic, bismuth and all such impurities. The lenses vary greatly in size after reaching 150 to 200 ft. in width and a length of 500 to 700 ft. The extent or position of these lenses is not indicated on the surface, the only indications being a leached iron stained porphyry with occasional surface stains and pockets of carbonate ore too low grade and small in extent to be of value.

* Reprinted by permission from The Mining World.

† Consulting Mining Engineer, Superintendent Azure Mining Co.

apart, each 300 ft. deep, will develop the same territory. Figuring \$1 per foot as cost of drilling (as a matter of fact we churn drill for about 50 cents and wages are high in this country), we have \$2,100, and adding \$2,200, the cost of our machine fully equipped laid down here, we have \$4,300 doing the work of \$30,000. This applies to practically only one 20 acre claim. We have about 800 acres of mineral land, a great deal of which contains copper. Of course, it can be said if the shafts and crosscuts hit ore, they are afterwards of use, while the drill hole is not. Suppose the ore is encountered 800 ft. from the shaft, then we have \$15,000 for shaft and \$12,000 for crosscutting. With the ground drilled first the shaft could be placed near the ore in the foot wall, and we have \$15,000 for shaft, \$1,000 for short crosscuts

and station and \$1,200 for drilling, or a total of \$20,200, making a saving of nearly \$10,000. It must be remembered that when two or three levels are developed, with the shaft a long way from the ore, the expense is much heavier, and this is generally necessary to lay out a mine.

The machine we are using is a No. 1 Combination, using cable, hollow rods, and core attachment. In hole No. 1 we used the cable tools to 150 ft., making a 4-in. hole; put on the core attachment, took a few feet of core which cut a 3-in. hole, found out the kind of rock we were in, filled the hole up with hard pebbles to the bottom of the 4-in. hole, put down our cable drill and reamed out the 3-in. hole and continued drilling. We can cut 30 ft. per 8½ working hours of 4-in. hole with the cable tools. We assay the mud that is pulled up with the sand pump. While chalcocite slimes badly we prevent loss of values by using very little water and keeping the mud thick. We encountered good ore at 235 ft. in our first hole, which was encouraging. We shall churn most of our holes, putting down a few core holes at 400 to 500 ft. intervals.

We move from hole to hole by using the hoist on the drill. Six barrels of water and three-eighths of a cord of juniper wood (equal to pine, cedar or similar soft wood in fuel value) is what we require.

The writer would point out that the costs for sinking, drilling (\$1 per foot), etc., include interest on all machinery, repairs, costs of assaying, superintendence, etc., not just the bare cost of actual labor. The 50 cents per foot for drilling is, of course, for labor, interest on drill, supplies, and allows \$1 a day for repairs, but does not include office expenses, superintendence, assaying, etc. We use a crew of three men, as we find the work goes faster.

In the monzonite porphyry, where we are working at present, a 350 to 400 ft. hole is deep enough to show the ore. The machine is equipped for 700 ft. complete in all three systems of drilling, and the writer is convinced the engine and boiler have ample power for that depth. The boiler is a rapid steamer and has the safety valve blowing half the time.

Reports of building operations of the Bureau of Statistics of the Department of Commerce and Labor for July, as indicated by 45 leading cities, continue to show improved activities. Even when compared with the large business of July, 1907, there is a small percentage of gain made by July of the current year. New York (including the boroughs of Brooklyn and the Bronx) shows a gain over July of last year, notwithstanding the large falling off of nearly 60 per cent in the two named boroughs. Birmingham, Cincinnati, Columbus, Denver, Indianapolis, Louisville, Milwaukee, Mobile, Nashville, New Orleans, Omaha, Paterson, Portland, Ore., San Antonio, Syracuse, Salt Lake City, Topeka, Toledo, Washington, and Wilkes-Barre show gains.

The Cost of Drilling and Blasting Copper Ore.

The following costs on drilling and blasting, and the methods of mining copper ore with a steam shovel at the Copper Flat Mines in Nevada, are abstracted from "Mines and Minerals."

The ore lies in a flat, and is estimated to be more than 200 ft. in depth, the ore occurring in a porphyry. It is capped with earth and rock to a depth of about 87 ft. This stripping and the ore are worked in trenches 50 ft. deep.

Cost of Drilling.—The holes are put down by two Keystone No. 5 traction drills owned by the mining company and kept continually at work drilling to loosen ground for the steam shovels. The Keystone No. 5 machine is built specially for mineral prospecting and mine work, it being the largest machine made by the Keystone Driller Co., of Beaver Falls, Pa. The boiler is mounted on the same trucks with the engine, and the machine is propelled on traction wheels. The engine is 11 H. P. The derrick is 34 ft. high. The machine weighs 16,000 lbs. and costs, without tools or equipment, \$1,375. This machine will drill holes from 1,000 to 1,200 ft. deep.

The drills use a 5½-in. bit which gives a hole about 6½ ins. in diameter, and the holes are put down to a depth of about 60 ft. The holes are spaced on 35-ft. centers and are back from the breast of the bench 40 ft. This is the usual spacing; however, where hard masses of tough carbonate ores are encountered, holes are about 15 ft. apart and 15 ft. from the breast. Each machine requires a driller, who is paid \$4 per day, and an assistant, who is paid \$3 per day. Nine-hour shifts are worked. A 60-ft. hole is put down in two shifts, or 18 hrs., thus 3 ft. and 5 ins. of hole is drilled per hr. For each hole the boiler burns 1 2-3 cords of wood, costing \$6 per cord. The cost of drilling one hole is as follows:

Driller	\$ 8.00
Assistant	6.00
Fuel	10.00
Oil and waste	.55
Extra parts, repairs, renewals...	2.15
Rope wear per hole.....	3.50
Estimated interest and depreciation	2.00
Total.....	\$32.20

This gives a cost per lineal foot of hole as follows:

Labor	\$.23
Fuel	.17
Oil and waste.....	.91
Repairs and renewals.....	.94
Rope	.05
Interest and depreciation	.93
Total.....	\$ 3.03

Cost of Blasting.—In blasting any material the amount of explosives used naturally varies with the location and depth of

holes and with the hardness of the materials. However, the average amount of explosives used in this work was obtained, and was as follows: The holes were sprung with two 50 lb. boxes of 40 per cent dynamite, costing \$15.40 for 100 lbs. Then the hole was reamed out, and from 20 to 30 kegs of black powder were used in the blast, the average being 25 kegs or 625 lbs., costing \$2.25 per keg. This gave a total cost for explosives of \$71.65.

Assuming that a block, 35x10x60 ft. is broken by the hole, we have a total of 3,111 cu. yds. of material moved by the blast. This amounts to 0.2 lb. of black powder per cu. yd. of material, or 0.23 lbs. of explosives per cu. yd. for both springing and blasting. This is a very small amount of powder to be used for rock blasting. The total cost per cu. yd. for drilling and blasting was:

Drilling	\$0.010
Blasting	.0023

Total.....\$0.0123

This cost of 3 1-3 cts. per cu. yd. is very low for the hard material. On the other hand, for the earth capping this cost is a little high; however, the cost given is an average for the two materials.

Steam Shovel Work.—Three 25-ton and one 70-ton Bucyrus steam shovels are used to load the blasted material. The dippers are equipped with manganese steel teeth, the repairs on them being very light. The shovels load the stripping into two way side dump cars of 3¼ cu. yds. capacity. The trains are pulled by 45-ton locomotives. Ten cars make up a train.

The ore is loaded into 50-ton bottom-dump cars for direct transportation to the concentrator. The ore is hauled by the railroad company and not by the mining company. Exact records of the cost of the steam shovel work are not available, but the work done by them in the first six months shows that the cost is much less than other methods in vogue in that part of the west, the saving being enough to make profitable the mining of low grade ores with this method, when it is not possible to make a profit on higher grade ores with other methods.

Press reports state that the Board of Aldermen of Duluth, Minn., are considering plans presented by a firm of French engineers, for the construction of an aerial railway like the famous Saarbrücken road in Germany, with cars suspended from a single trestle. The railway will be a suburban line running along the hill top and the avenues will be provided with moving sidewalks to carry the people up the hill and act as feeders for the new line.

The Board of Local Improvements of Chicago, Ill., is to at once call for bids for constructing trunk sewers in Western avenue and Kedzie avenue, from 71st street to the drainage canal. The sewers will cost about \$900,000.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods and Costs; Some Old; Some New.

Supporting Young Trees.—In some of the English towns a stout, larch pole, known as a ricker pole, is used to provide a support for young trees. This pole is about 14 ft. long and is driven well into the ground, the tree being secured to it by means of wire wound round it, a strip of tarred felt to prevent the wire cutting into the bark also being used. The ricker poles before being used are stripped of their bark for 2 ft. from the bottom, pointed, charred over a fire, and then dipped in boiling tar to prevent the underground portion from decaying.

Cost of Cleaning Sewers and Catch-basins.—The following table shows the cost of sewers cleaned in the city of Chicago during the year 1907:

Method.	Feet Cleaned.	Total Cost.	Average Cost.
Flushing	2,485,900	\$29,060	\$1.17
Iron scraper...	488,700	32,161	6.58
Wood scraper..	6,200	204	3.29

A total of 24,974 catch basins were cleaned at a cost of \$96,522, the average cost per basin being \$3.86. The work is done by day labor by the bureau of sewers, common labor being paid \$2.50 per day of 8 hours.

Cost of Repairing Asphalt Pavement.—The first asphalt pavement in the city of Rochester, N. Y., was laid in 1885. The guarantee expired in 1890 and the pavement came under the care of the city in 1891. The area and cost of repairs on asphalt pavements on which the guarantee had expired are given in a report of the city engineer as being as follows for the respective years:

Year.	Sq. Yds.	Repairs.	Cost per sq. yd.
1891	9,482	\$ 0.00	0.00
1892	19,870	0.00	0.00
1893	43,670	0.00	0.00
1894	48,804	0.00	0.00
1895	60,329	76.62	0.12
1896	126,869	539.06	0.43
1897	172,276	7,185.56	4.21
1898	253,280	4,895.33	*1.87
1899	301,922	5,057.34	†1.67
1900	357,459	7,711.61	‡2.11
1901	392,282	12,396.81	‡3.17
1902	427,252	20,134.25	‡4.72
1903	434,405	15,347.79	‡3.53
1904	447,811	22,505.67	‡5.02
1905	453,750	21,317.62	‡4.69
1906	453,750	25,663.51	‡5.66

*Excluding rock asphalt pavements—2.20 cts.

†Excluding rock asphalt pavements—2.34 cts.

‡Rock asphalt repairs included.

The total amount of sheet asphalt pavements on which the guarantees expired previously to Jan. 1, 1907, was 27,703 miles, or 453,750 sq. yds. This amount is made up of 222,495 sq. yds., Trinidad Lake asphalt, 117,886 sq. yds., rock asphalt, 113,369 sq. yds., Vulcanite asphalt.

Macadam Road Construction.—In some sections of Massachusetts where the rock is soft it has been customary to reverse the usual form of road construction by having the bottom course the nut size and the second course the egg size. Regarding this Mr. D. H. Winslow, Resident Engineer, Massachusetts Highway Commission, writes as follows: "It is now noticed these roads do not ravel as readily as those where the egg size is at the bottom. The inference is that the auto does not as readily pick up the large stone as it does the smaller size. Contractors in some sections have maintained that the macadam is put on in such sizes that there is a large waste product—dust—and that a better road could be made of large-sized stone. At crushing plants usually 5 to 10 cts. a ton additional is charged where only the nut size is ordered. In a number of the resurfacing jobs recently let the contract calls for the egg size alone, with a binder of sharp sand afterwards followed by the regular screenings, rolled and flushed. It will be interesting to note whether this type of road will withstand the automobile travel better than the regular type of macadam or not. If it does, then the effect should be a reduction in the cost of crushing, as the grinding would not have to be so fine."

Experiment to Determine Well Contamination.—In 1903 the town of Quitman, Ga., made a boring for a deep well, which penetrated at a depth of 123 ft. in limestone, in what appeared to be a cavity 6¾ ft. deep. The resulting conditions were such as to lead into the conclusion that the cavity was the channel of a large subterranean stream. A second well was constructed with a view of testing more fully the water bearing capacity of the underground cavity. The second well was 6 in in diameter and was put down a few hundred yards southwest of the first well and within a few feet of Russell pond, a small body of stagnant water. This well after being sunk to a depth of 120 ft. to the cavernous limestone was connected with the pond, which contained about 500,000 gallons of water. The water was drained by the well in a few hours and the town authorities at once began to consider making use

of the so called underground cavity for sewage disposal. Finally it was determined to conduct an experiment to determine the possibility of contamination of adjacent wells and springs by the sewage, the plan adopted being the chlorine method of tracing underground water courses. Accordingly surveys were made to find all wells and springs whose water level was lower than the water in Russell pond well, where the chlorine (sodium chloride, common salt) was to be introduced. Samples of water were taken from all such wells for the determination of the normal amount of chlorine and various stations established, after which two tons of salt were introduced into the Russell Pond well. The salt was put into the well in the form of solution, its introduction beginning at 8 a. m., Oct. 15, and continuing until 8 p. m., Oct. 20. The first ton of salt put into the well was introduced continuously for twelve hours at the rate of 166¾ lbs. an hour, while the second ton was put into the well continuously for 120 hours, or five days, at the rate of 16¾ lbs. an hour. In order to introduce the salt into the well at the above rate and also to insure as complete saturation of the water as possible, five 50-gallon barrels were set about 20 ins. apart upon a level platform at the well and connected with one another by pieces of 2-in. iron pipe, firmly screwed into the barrels by right and left screws cut on their opposite ends. The iron pipe was inserted into the barrel nearest the well about 2 ins. from the bottom, while the pipe between each succeeding barrel was elevated about 4 ins., so that the one uniting the last two barrels entered them about half way up. When everything was in readiness for the experiment to begin, each barrel was filled with salt up to the point at which the outflow pipe entered it. The water was then turned into the barrel farthest from the well through a hydrant connected with the public water supply. As the water rose in this barrel to the point of entrance of the pipe it flowed into the next barrel, and so on until the entire chain of barrels was filled. The water now being more or less completely saturated, having flowed over the salt in the bottom of each barrel, was turned into the well through a stopcock so adjusted as to deliver the desired amount of water per minute. By a nice adjustment of the stopcock at the well and of that at the hydrant it was found that this plan of delivering a given amount of brine to the well in a stated time was practically automatic, the attendant having nothing to do except to keep the bottoms of the barrels supplied with salt. As a result of the experiment it was concluded that sewage introduced into the first water bearing stratum would contaminate all of the wells in the vicinity that attained a depth of 120 ft. or more. The experiment is more fully described in Bulletin 15 of the Geological Survey of Georgia, from which the above note has been taken.

The Inspection of Structural Steel.*

BY P. S. HILDRETH.

Like many other branches of professional work, the supervision of manufacture of iron and steel work has become a specialty, and is best accomplished by the employment of reputable and experienced inspecting engineers. To judge of the value of the services of such specialists, they should be weighed in the same scales as other experts: experience, judged from years and variety of work; facilities, by the number and location of assistants; methods, by the character of records furnished, and reputation, by the class of work done and references. Least of all is the charge for services. The value is dependent largely upon the conscience and thoroughness of the principal and assistants, and is not a commercial product to be bought from the lowest bidder; in fact, low terms can mean nothing else than poor service. Terms, by custom, are made per ton, and there is a proper variation in cost of inspection of a light, complicated structure, or a heavy, straight one. They may properly vary from \$1.00 to 70c per ton for mill and shop inspection, and from \$150 per month to 25 cts. per ton for inspection of erection when desired.

Inspection of the manufacture of iron or steel work is not a part of an architect's services, particularly as it is of marked value to both the general and the steel contractor in the information it furnishes the former and the delay and expense it saves to both. It is therefore customary for leading architects to specify that the general contractor shall employ inspecting engineers, but as he may defer to the steel contractor, and it is important that they should be absolutely independent, a clause about as follows is generally used:

"The material of all members under calculated stress shall be tested and all materials and workmanship shall be inspected at the original points of manufacture by inspecting engineers appointed by the architect, and subject to his removal. The cost of such inspection shall be paid by the general contractor at the rate of — cents per ton of structural iron and steel required for the building. The inspectors shall represent and report to the architect and general contractor with the view of securing the prompt and orderly delivery of members of material and workmanship specified."

In addition to this clause there should be others requiring the steel contractors to furnish proper facilities for testing and inspection without charge, and to promptly replace rejected material or workmanship; also, that such inspection or lack of inspection shall not relieve the contractor from responsibility under the contract and specifications.

The details of good inspection of structural steel during manufacture are stated

below, and are supplemented with a few examples of the value of such inspection.

As a general principle, it is essential that the manufacture of cast-iron and steel and the fabrication of steel shapes in the shops should be supervised during their entire progress, rather than merely passed upon after portions of the work are completed. It is only by such supervision that errors and defects can be prevented, the general character of workmanship improved and delays necessary to make corrections avoided. Some defects, if not discovered until work is finished, can never be entirely satisfactorily corrected unless the entire member is rejected and replaced, which is often impracticable. When inspection is intelligently conducted on these lines it is welcomed by the best manufacturers, and is of assistance to them in promptly and properly getting out their work.

During the rolling of steel at the mills or casting of iron at the foundries, inspectors should be present and have knowledge of the stock used. They should personally choose representative test specimens and personally make the tests, in order to be able to testify in court if necessary. They should see that chemical analyses are the specified determination and personally take drillings for check analyses when desirable. As the material is cut, straightened and handled for loading, they should inspect it for accuracy of section, weight and all classes of physical and surface defects. Particular attention should be given to castings by sounding, striking edges and examination. They should report as to the tonnage of material cast or rolled and shipped, and send a list of the material accepted and rejected with corresponding detailed records of tests identified as applying to certain material. The bending test is best reported by an outline of the actual bend. Every piece of material should be accounted for. They should also report as to the prospects of securing material, and advise purchasers as to when material may be expected from the foundries or mills, and expose the falsity of statements frequently made by shops that they cannot secure material when such statements are untrue.

During shop manufacture, inspectors should be familiar with the plans and check them for clearance and compliance of shop-working plans with general plans as to main sections. They should supervise the shop work from its start, carefully watching the material for mechanical defects, particularly during punching and other manipulations, assembling of members, including preliminary comparisons with plans, matching of holes, painting of surfaces in contact and surfaces inaccessible after erection (two coats), straightness of members, riveting, facing, boring and finishing. After members are finished, and before painting is done, they should make a careful final inspection and detailed comparison with plans. They should finally see

that members have all scale and rust removed and are thoroughly painted with specified paint on dry surface, are correctly marked, and are so loaded upon cars as to prevent injury during transportation. They should report weekly as to the progress of the work in the shops, showing in detail the number of pieces required, those being manufactured and those shipped. In special cases they should report the progress of manufacture and shipments daily by wire.

When work is let at a pound price, and when required, the inspecting engineers should estimate the weights of members, and in all cases inspectors should watch the scale weighing, and when weights are estimated, make a comparison of each member with its estimated weight.

When inspection is finished there should be rendered a complete final report giving a brief history of the work and describing the inspection. It should include the records of all material inspected, with the corresponding tests, rejections, variations from specifications, errors, methods of correction, statement of weights and dates of shipment, and other matters of interest, and should be a convincing certificate of the character of materials and workmanship, and all records should be original papers signed by the inspector in charge, rather than copies, in order that, if necessary, such records may become competent evidence in court, and under any circumstances will demonstrate to the architect and owner the actual performance of the in a general office or the copying of mill or work rather than the making up of results shop records.

On important contracts the individual men on the work should be known to the architect and subject to his discipline or discharge. All reports should be rendered to the architect, with copies to the contractor and copy of final report for the owner. In general the inspection should be absolutely thorough, honest and complete. There is no man but makes mistakes, and commercial conditions of manufacture and the best methods of testing do not give absolute assurance; nevertheless, honest and competent inspection is of established value.

The following examples of errors or defects rejected or corrected under competent inspection are of interest:

Of an order of cast-iron bases for a fourteen-story office building, twelve of the first seventeen cast cracked in cooling or when struck by a sledge, and showed dangerous initial strains caused in cooling; three showed open spaces inside. All were rejected and built steel bases substituted.

In a large department store cast-iron columns were used. At the foundry a considerable number were found with lugs, on which floor girders rested, hollow—apparently sound, but merely shells. The defect was apparently caused by the fact that in casting, these lugs were uppermost and the sand slightly green; when the metal was poured steam formed and the hot metal

* Reprinted from the "California Journal of Technology" for August, 1908.

w. blow up into the lig. forming a perfect surface, but stopping the vent and making an air pocket. The unsound ligs were discovered by careful sounding with a hammer. Had the columns gotten into the building a serious failure would no doubt have occurred.

The shifting of the core in casting columns frequently occurs and gives an eccentric distribution of metal and an element of danger. It is discovered by measuring through test holes.

There are many cases of beams, channels, or other shapes which are extremely brittle and break into two or more pieces under slight shock, such as unloading from a truck. This is a frequent defect of Belgian material; but not uncommon in this country, and is due to an excess of phosphorus or over heating. It is discovered in chemical analyses, in the action of the material under punching and often in cracked metal at rivet holes; it is sometimes indicated on the surface by fine cracks or ragged edges. All such material is extremely dangerous under important live loads, such as machinery, and would probably be a source of failure in the event of earthquake shocks, even if slight.

A large brewery stock house, with exceptionally heavy loads, had built columns of latticed channels heavier than the minimum section. They were ordered and rolled scant 15 per cent in weight, and rejected at the shop on comparison with the general plans. The defect was rectified by substituting plates for the lattices, and a delay of over a month avoided.

A 21-in. I-beam, to be used as a track girder for a large traveling crane in a power-house, was rolled with ragged edges. It was rejected by the mill inspector, and shipped in spite of his rejection. The cracks were neatly puttied up, and it was offered to the shop inspector, who, being advised and on his guard, discovered and again rejected it. The suggestion of the shop to rivet on cover plates was declined, as the beam itself was defective. It was seen to be properly replaced.

Many defects of punching, assembling and fitting occur in the shops. Many thousand loose and burnt rivets are driven, and rivets are frequently omitted; many errors of dimensions occur.

A building had over 50 columns in the basement tier; the first one was found to be one foot too short, due to an error in the templates. All subsequent columns were made of correct length, and a serious delay and large loss to the steel contractor avoided.

On heavy and long columns the heat of the rivets driven in a long single or double row tends to cause a twist which makes good connections difficult and, if the error multiplies, tier upon tier, impossible. It can always be discovered by a competent inspector, and avoided by driving rivets for short distances around the column.

In a 21 story building the shop ordered the material for the exceptionally heavy columns a trifle short; it did not face to a full bearing, and the defect was rectified by using additional splice plates. In the same building errors of length of columns occurred as much as $\frac{1}{2}$ in. and were corrected by carefully planed filler plates or compensated by increased length in upper stories. Many connection brackets were misplaced and built up or correctly related. The inspector in charge handled the work so well as to be subsequently employed by the shop as assistant superintendent; he undoubtedly saved many days' time and large expense to the steel contractor, compared with the necessity of correcting such errors at the building site, even in cases where corrections were possible there.

Many cases occur of ends of columns not faced square to the axis of the column; in abutting column sections the error may double. It is readily discovered by a competent inspector and corrected by milling off square and using a well fitting filler plate.

Some exceptionally heavy built girders were specified to have reamed holes; the shop punched them full size. They were required to be reamed for 1-in. rivets, and additional cover plates used to develop the full strength.

In a number of important roof trusses there were two sets of members of the same length and shape, but different cross section; in the shop they were reversed in place with a reduction of strength of 25 per cent. The error was found and corrected by cutting the trusses apart and correctly placing the members.

Many connecting angles of beams are incorrectly placed, either not square or so as to give greater or less length than designed. They can be readily discovered and corrected at the shop, but give great annoyance at the building, and generally are forced in place and materially reduce the strength and stiffness of the frame.

The lack of thorough painting or substitution of a cheaper paint for a specified brand is of constant recurrence in the shops. The life of steel work in a building is undetermined, yet architects agree it should be well protected, and if a good brand of paint is specified it should be used.

The knowledge that material is loaded and shipped in good order is a matter of importance in fixing the responsibility for injury during transportation or subsequently.

Knowledge of the actual weights, certified to by an independent inspector, is of importance in adjusting "extras." Many errors of misstatements occur. Similarly knowledge of delays and time of starting work or making shipment is important in adjusting penalties for delays, and the information secured by an inspector is of special value as tending to prevent improper claims and disputes.

Contract Prices on Road Work in Cuba.

The road, which was telford-macadam, four miles long, was situated on the main road from Havana (the capital or the province of the same name) to Batabano (the Seaport on the south coast), in the province of Havana. It was three miles from Benical, situated on the United Railways of Havana and "La Salud," situated on the Western Railway of Havana, lay two miles to the south. Both towns were connected with the work by a telford-macadam road.

The cost of materials and labor was as follows:

Portland cement, \$3.50 per bbl
Soft coal, \$20 per ton.
Labor, \$1.20 per 10-hour day.
Foreman, \$75 per month.
Sub-foreman, \$1.50 per day.
Timekeeper, \$1.50 per day.
Machinist road roller, \$3 per day.
Rent to government for road roller, \$10 per working day.

Rock crusher, including coal and engineer, \$7.50 per day.

Mule carts with driver, \$2.50 per day.

Ox carts (1 yoke), \$2 per day.

Four-ton road roller with three yoke of oxen, \$3.50 per day.

The longest haul for rock was 1.5 miles.

The contract prices were as follows:

9,180 cu. yds. earth excavation at 19.5 cts.....	\$ 1,790.10
1,021 cu. yds. rock excavation at 56 cts.	571.76
20,726 cu. yds. embankment at 28 cts.	7,183.28
4 miles telford-macadam (6 ins. telford, 4 ins. macadam), at \$6.030 per mile.....	24,120.00
16,404 lin. ft. moving and rebuilding dry rubble stone fence 3.5 ft. high at 19 cts.....	1,176.36
27,559 lin. ft. 7 strand barbwire fence at 7 cts.....	1,929.13
131 lin. ft. (22.5 ins. diameter) cement pipe at \$3.60	479.46
1 reinforced concrete culvert (1 meter or 3.29 ft. by 7.50 meters) or 23.66 ft.....	450.00
1 cement and brick section house for two families of road-menders.....	4,600.00
Total	\$41,900.09

The contractor made a profit of 8 to 8.5 per cent on the entire contract. Mr. Chas. McKercher, assistant engineer, department of public works, Camaguey, Cuba, was engineer in charge of the work and we are indebted to him for the information given above.

According to a recent consular report there were in Europe in 1907 125 universities having a total attendance of 228,732 students. Of these the university at Berlin had the largest number of students, 13,884; next came Paris with 12,985, Budapest with 6,551, and Vienna with 6,205.

Methods and Cost of Laying 6-in. and 8-in. Wrought-Iron, Screw-Joint Pipe for a Compressed Air Main*

The work consisted of laying 7,000 ft. of 8-in. and 1,000 ft. of 6-in. wrought-iron, screw-joint pipe for a compressed air line carrying 80 to 90 lbs. pressure. The work was all performed by common labor, none of the men being experienced in pipe laying.

The greatest cause of delay in laying screwed pipe is the difficulty in getting each successive length of pipe into line and keeping it there until the first threads take hold and the pipe begins to screw together. To overcome this difficulty a cradle for supporting the pipe at the joint,

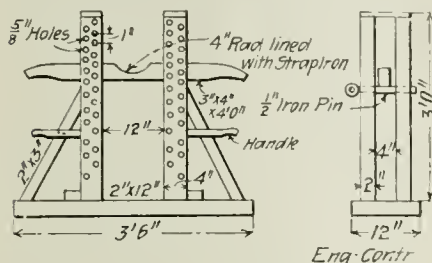


Fig. 1—Jack for Holding End of Pipe.

a jack for adjusting and supporting the outer end of the pipe and a straight-edge for lining the pipe were devised. The cradle holds the threaded end of the pipe in position to enter the sleeve coupling on the last joint laid; the jack allows both vertical and horizontal adjustment of the joint of pipe; and the straight-edge shows when the pipe is in line ready to screw together. The cradle was simply a wood block, 8 x 8 ins. x 24 ins. in length, with a groove having a 4-in. radius cut in its top. The jack is shown by Fig. 1 and the straight-edge by Fig. 2. The movable block on the straight-edge is necessary because it is almost impossible to make a 12-ft. straight-edge that will remain true for more than a day.

These devices saved fully 50 per cent over the crude and unsatisfactory method of using blocks to hold the pipe in line. There was no straining and lifting to hold the pipe in place, and as the pipes were started together straight there were no stripped threads and bad joints, and the pipe made up so easily that one man with a pair of 3-ft. tongs often screwed an 8-in. pipe half way up; it was then completed by four men using two pairs of tongs with 8-ft. handles.

The threads, both male and female, were cleaned with wire brushes. Dixon's pipe joint compound was used on all screwed joints. Ring gaskets of 1-16-in. Rainbow packing were used on flange joints, the gasket being pasted to one flange with

coal-tar roofing paint, which held it in position while the joint was being made.

Six-Inch Pipe Line. The total length of 6-in. pipe was 1,118 feet. The pipe was 6-in. lap welded casing weighing 15 lbs. per lin. ft. It was laid with sleeve couplings, 11½ threads per inch, with a flange union every 150 ft. and U-bends for expansion every 500 ft. The average length of joints was 29.1 ft.; an average of 588.2 ft. of pipe or of 20.3 joints, was laid per 10 hour day. The best day's work was 1,065 ft., or 33 joints, with 6 men working 9 hours, making 177.5 ft. per man; the poorest day's work was 120 ft., or 6 joints, by 6 men working 9½ hours. The work was done from Aug. 15 to 21, 1907, in fair weather except for one day when the men worked 1 hour in rain and laid 22 joints. The men walked 2½ to 3 miles to and from work. The average gang was: 1.85 men at 20 cts. per hour, 1 foreman at 30 cts. per hour, and 1 waterboy at 10 cts. per hour. The cost of pipelaying was as follows per 100 ft.:

Items.	Per 100 ft.
Clearing right of way	\$0.327
Hauling and distributing	1.578
Blocking to grade	0.116
Constructing bents	0.450
Anchors for U-bends	2.290
Painting	0.900
Tools	0.100
Testing	0.300
Laying	3.137
Surveying and superintendence.....	0.760
Total	\$9.898

The total cost per foot exclusive of cost of pipe was 9.898 cts., or, say, 10 cts. The following notes explain the work included in the various items:

Clearing.—Removing small brush for a width of 10 ft.

Hauling.—The average hauls was 3,000 ft. over bad roads, steep and rough. This item includes loading pipe on cars and unloading, hauling and distributing, including seven U-bends. Teams and drivers got \$3 per day.

Blocking.—Includes temporary blocking and bending pipe in five places by building fires on it.

Anchors for U-Bends.—Includes 8 piers at \$12 each, including bolts and clamps.

Bent Construction.—Includes carpenter work only on about 20 bents, averaging 3 ft. in height and made of 1x6-in. stuff.

Painting.—Includes cost of painting and cleaning pipe with wire brushes with paint costing \$1 per gallon and labor at 20 cts. per hour. The pipe was painted one coat.

Tools.—Includes shovels and depreciation.

Eight Inch Pipe Line. The total length of 8-in. pipe was 7,101 ft. The pipe was 8-in. O. D., lap-welded casing weighing 20 lbs. per foot, laid with sleeve couplings, 11½ threads per inch. The average length of joints was 19.15 ft. There was a flange union every 150 ft. and U-bends for expansion every 600 ft. An average of 503.6 ft. was laid per day, of 10 hours, or 263 joints. The best day's work was 613 ft., or 32 joints, by 6 men, including foreman; the poorest day's work was 380 ft. or 20 joints, by 7 men, including foreman. The work was done from July 2 to Aug. 5, 1907, the weather being hot and sultry, the thermometer ranging from 85° to 100°, and averaging 90° in shade. The average gang was: 5.92 men at 20 cts. per hour, 1 foreman at 30 cts. per hour, and 1 waterboy at 10 cts. per hour. The cost was as follows per 100 ft.:

Items.	Per 100 ft.
Surveying and superintendence.....	\$1.000
Laying	3.580
Clearing	0.187
Hauling and distributing	1.032
Blocking to grade.....	1.110
Constructing bents	1.069
Anchors for U-bends	2.535
Painting	1.200
Tools	0.102
Testing	0.388
Total cost of laying.....	\$12.203
Cost of pipe	76.400

Grand total cost **\$88.603**

The total cost per foot, exclusive cost of pipe, was thus 12.2 cts., and including cost of pipe 88.6 cts. The following notes

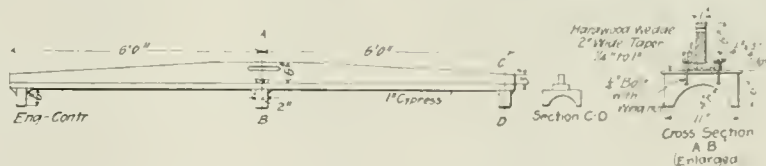


Fig. 2—Straight Edge Used in Cementing the Pipe.

explains the work included in the various items:

Clearing.—Removing small brush for a width of 10 ft.

Hauling.—Includes 12 U-bends, which cost \$1 each to haul; teams and drivers 30 cts. per hour, laborers 20 cts. per hour, and foreman 30 cts. per hour.

Bent Construction.—Includes carpenter work only on about 80 bents of 1x6-in. stuff, spaced 30 ft. apart and ranging in height from 1 ft. to 16 ft., averaging 6 ft. high.

Anchors for U-Bends.—Includes 12 piers at \$15 each, including bolts and clamps.

Painting.—Same as for 6-in. pipe.

Testing.—Includes laying and connecting 200 ft. of 4-in. pipe to pump line. Tested to 110 lbs. hydraulic pressure. Leaks developed in two tees in line and

*Rearranged from an article by E. E. Harper, Ward & Harper, Civil and Mining Engineers, Sturgis, Ky., in *Engineering News*, Feb. 27, 1908.

these were repaired. Line tested again and found tight.

Cost of Pipe.—Cost f. o. b. McKeesport, Pa., \$76 per 100 ft. (per ton); freight from McKeesport to Flat River 40 cts. per ton (per 100 ft.).

Itemized Cost of Bridges, Turnouts, Culverts for Main Canal Payette-Boise Irrigation Project.*

The work consisted of the construction of 18 highway bridges, 6 turnouts and 3 combination culverts and wasteways and of the Indian Creek diversion works on the main canal on the Payette-Boise project. The average distance of these works from railroad stations is somewhat less than five miles.

Work under the contract was initiated during September, 1907, and was completed during May, 1908. The weather through-

But a small number of laborers were employed and these consisted mainly of skilled laborers and carpenters. During the fall of 1907 labor was scarce, and men for concrete work were secured by paying from 25 to 50 cts. per day in excess of the wages for common labor. During the latter portion of the contract labor was much more plentiful. All work was performed on the 8-hour basis except for a very short time at the close of the work. The following rates of wages per 8-hour day were paid: Foremen, \$4.00 to \$4.50; carpenters, \$3.50 to \$3.75; common laborers, \$2.00 to \$2.75; skilled laborers, \$3.00; two-horse teams and drivers, \$4.50 to \$5.00.

The materials furnished by the contractor consisted of lumber, bolts and tie-rods for highway bridges and reinforcing steel for concrete. All cement was furnished by the United States f. o. b. cars at the railroad station nearest the works. A portion of

41.8 cu. yds., and the largest 145.5 cu. yds. The concrete was mixed with a Smith concrete mixer and hauled into place in wheelbarrows. The aggregate used was a natural mixture of gravel and sand that required no screening. The average haul of gravel and water was about one mile. The floor of the turnouts was composed of a mixture of 1 part of cement to 8 parts of aggregate, and the superstructure of 1 part of cement to 7 parts of aggregate. The concrete was reinforced with round steel rods.

The concrete for the combination culverts and wasteways was made of the same materials, mixed in the same proportions and handled in the same manner as was that in the turnouts, the average distance of haul being also about the same. The smallest structure contained 134 cu. yds. and the largest 270.9 cu. yds. of concrete. The same character of reinforce-

COST OF BRIDGES, TURNOUTS AND CULVERTS IN THE PAYETTE-BOISE IRRIGATION PROJECT.

Distribution of Cost.	Bridges.			Turnouts.		Culverts.		Indian Creek Diversion Works	
	Concrete, 291 cu. yds. Unit cost	Bolts and tie rods, 5,930 lbs. Unit cost	Lumber, 172,561 ft. B. M. Cost per M.	Concrete, 600 cu. yds. Unit cost	Reinforced steel 4,314 lbs. Unit cost	Concrete, 638 cu. yds. Unit cost	Reinforced steel, 3,665 lbs. Unit cost	Concrete, 760 cu. yds. Unit cost	Reinforced steel, 2,450 lbs. Unit cost
Interest on investment.....	\$0.28	\$0.001	\$ 0.53	\$0.25	\$0.001	\$0.18	.....	\$0.25	.....
Preparatory expense.....	.....	.....	.....	.30	.....	.12	.....	.09	.....
Plant depreciation.....	.....	.....	.....	.31	.....	.12	.....	.59	.....
Executive.....	.13	.....	.41	.20	.....	.....	.....	.....	.....
Labor—	.....	.....	.....	.....	.....	.14	.....	.19	.....
Erecting forms.....	.75	.....	.....	1.21	.....	1.08	.....	.74	.....
Mixing and placing.....	1.82	.....	.....	1.03	.....	.73	.....	1.27	.....
Breaking stone.....	.....	.....	.....	.....	.....	.....	.....	1.53	.....
Hauling gravel.....	1.37	.....	.....	1.30	.....	.73	.....	.....	.....
Hauling sand.....	.....	.....	.....	.....	.....	.....	.....	.23	.....
Hauling cement.....	.52	.....	.....	.23	.....	.26	.....	.26	.....
Hauling water.....	.35	.....	.....	.19	.....	.08	.....	.10	.....
Hauling lumber.....	.....	.....	2.95	.....	.....	.....	.....	.....	.....
Placing.....	.....	.014	6.20	.....	.014	.....	\$0.005	.....	\$0.008
Materials.....	.....	.079	29.04	.....	.040	.....	.070	.....	.070
Supplies.....	.30	.....	.06	.60	.....	.65	.....	.99	.....
Total contractor's unit cost.....	\$5.61	\$0.094	\$39.19	\$5.62	\$0.055	\$4.36	\$0.075	\$6.23	\$0.078
U. S. materials, cement.....	2.27	.....	.....	1.66	.....	2.18	.006*	1.79	.....
U. S. force account, excavation and backfilling.....	.....	.....	.....	1.07	.....	1.79	.....	.22	.....
U. S. engineering.....	.91	.003	2.96	.81	.007	.74	.007	.36	.018
Total unit cost.....	\$8.79	\$0.097	\$42.15	\$9.16	\$0.062	\$9.07	\$0.088	\$8.60	\$0.096
		*Steel.							

out the continuance of the contract was especially favorable for the performance of the work, it being possible to place concrete throughout the cold weather and to haul materials without exceptional difficulty at all times.

The total cost of the work to the contractor is estimated at \$22,565.98. Interest on the contractor's investment amounts to 2.9 per cent of the total cost of the work, preparatory expense to 1.9 per cent, plant depreciation to 3.5 per cent, superintendence to 2.2 per cent, labor to 55.3 per cent, materials to 27 per cent and supplies to 7 per cent thereof.

The plant used by the contractor was small and belonged mainly to sub-contractors. The major portion of the work was performed by sub-contractors, the only work done by the contractors being the construction of the first five bridges.

the cement cost the United States \$2.52 per barrel delivered at the railroad station and the remainder \$2.83. The United States did all excavating for the foundations and all backfilling in connection with the turnouts, culverts and Indian Creek diversion works at a total cost of \$1,950.64.

There were two hundred and ninety-one cu. yds. of concrete used in the construction of the bridge abutments, about 18 cu. yds. being required per bridge. The gravel and sand had to be hauled a considerable distance. The concrete was mixed in the proportion of 1 part cement to 8 parts of gravel and sand. The stringers and flooring used in the bridges consisted of common fir of good quality, and cost the contractor \$30 per M. ft. B. M. f. o. b. cars at the railroad station. The lumber for the remaining parts of the bridge was purchased in the local market at \$25 per M. ft. B. M.

The smallest concrete culvert contained

ment was used in these structures as in the turnouts.

The Indian Creek diverting structure contains concrete headworks for six cast-iron gates and a concrete waste weir and wasteway. As there was no gravel near by for use in the concrete, crushed rock was made of lava rock, which existed in abundance near at hand. The aggregate was composed of this crushed rock and sand hauled from a distance. The concrete in the floors of the structure was mixed in the proportions of 1:3:5, and that in the walls in the proportion of 1:4:6. Large pieces of rock were imbedded in the walls, forming a sort of rubble concrete. Some little steel reinforcement was used.

The accompanying tabulation shows the distribution and unit costs of the concrete and also steel and lumber in the bridges; also the cost of concrete and steel in the turnouts, culverts, and diversion work.

*Reprinted from "Reclamation Record" for September, 1908.

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How Can I Get to Be an Inspector?

This question comes to us from a bright young workman. Many engineers and contractors doubtless have had the same query put to them. It is worth a plain answer. The inspector is a far more common employee now than he was even a decade ago. Concrete work alone, depending so much for its success on rigid and competent inspection, calls for a large number of inspectors. Construction works of all kinds are greater and more expensive than they were. "How can I get to be an inspector?" is a pertinent question.

In the first place: Do you want to be an inspector? The position does not command high pay or great honor. The pay is not so great as that of a bricklayer or skilled workman of almost any class; the contractor generally holds the inspector in subdued contempt and the engineer gives his position no great respect. Of course there are exceptions. Of course also such conditions should not be, but they are and the man who thinks of becoming an inspector should discount them. There are no cakes and ale in the role of the inspector if he does his work thoroughly and honestly.

To the practical workman who is desirous of becoming an inspector we would recommend that his first effort should be to acquire a theoretical training such as is offered by one of the better correspondence schools. The fees are moderate and their methods are amply good for the purpose. A training in the theory of engineering design and construction is essential to the highest positions in inspectorship. The better the training is the better is one's chances of advancement. You will hear many practical inspectors contend differently. Numerous cases will be quoted where student inspectors from engineering schools have made foolish decisions on practical questions, and absurdities in the requirements of engineering specifications will be pointed out. Don't be misled by these things. They do not signify that theoretical training is useless, they show merely that the theoretical training of the man had not been tempered by a corresponding knowledge of practical work.

In addition to securing the best theoretical training that he can the workman who is studying to be an inspector should possess himself of the best knowledge of costs that he can. This he is in position to do for himself. As an inspector he will have to measure up work for monthly estimates and a knowledge of material and labor costs is essential. The value of a knowledge of costs goes farther than this, however. It puts the inspector in position to compare methods of doing work and to distinguish between apparent and real economies. The man who can clearly estimate the cost of doing engineering work is the rarest sort of a man to find.

Another ability that the workman should strive for is that of reading engineers'

plans quickly and accurately. He is the one who will be most often called upon to explain obscure details to puzzled foremen. He should be able to do it clearly and concisely. This is necessary not only that the work may be done accurately and without delay, but also because it gives the inspector himself standing with the men and with the contractor and so increases his influence and his value. The course of theoretical study that has been suggested will do much to train the student in reading drawings and it will also teach him to make drawings. But in addition he should secure and study actual working plans and he should develop the ability to sketch out obscure details for the men doing the work.

Along with his study of plans the student should read and analyze specifications to familiarize himself with their phraseology and its meaning and with the requirements demanded of materials and workmanship. The interpretation of specifications is the rock of argument upon which the contractor and the inspector most often split. While the inspector always has the engineer to fall back upon he should not be forced to this resort if he can possibly avoid it. He can avoid it only by being able to interpret accurately for himself the ordinary specifications. Moreover if he can make the correct interpretation unflinchingly the dispute when carried back to the engineer will be decided in his favor and his authority and knowledge will be enhanced in the eyes of the contractor and the workmen.

Knowledge of materials and workmanship must be assumed of the workman who would fit himself to be an inspector. Unless he has this knowledge to start with he has little reason for his ambitions to change his vocation. It is the one asset which gives him the advantage over the school trained inspector. He can never possess too much of this kind of knowledge, and he should never cease striving to increase it.

In the foregoing we have touched only the outskirts of the things necessary if one wishes to get to be an inspector. The position is an honorable one and one that should command adequate pay. It does not usually receive adequate pay, however, and this is perhaps the greatest drawback to good inspection of engineering construction that we can name, outside of the practice of selecting inspectors on the basis of political pull.

During the 26 working days in July steam shovels Nos. 256 and 262 at work in the Culebra Cut of the Isthmian Canal took out respectively 54,927 cu. yds. and 53,440 cu. yds. of material, surpassing all excavation records made since the beginning of American control. The output of Shovel No. 256 consisted of 35,716 cu. yds. of earth and 19,211 cu. yds. of rock. Shovel No. 262 excavated 2,672 cu. yds. of earth and 50,768 cu. yds. of rock. Both shovels are 95-ton shovels with 5 cu. yds. dippers. The shovels are under steam for 8 hours per day.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Metal Forms in Reinforced Concrete Construction.*

BY W. L. CMLDWELL.†

To obtain the true value of concrete as a structural material, it must be put to place in plastic form and be left to set or harden without being disturbed, and as the amount of steel that is necessary to reinforce it is not sufficient or so placed as to carry the concrete while going through the hardening process, some independent means must be employed to confine and support the concrete and steel until the former has become hard and taken firm and everlasting grip on the reinforcement.

Up to the present time lumber has been employed for this purpose almost exclusively, but as the price of lumber increases (as it of necessity must do) and the price of steel products becomes cheaper, the time will come when the former will be abandoned and the latter substituted, even though the latter have no advantage over lumber.

Wooden forms or centerings for concrete construction are the "bugbear" of all engineers and constructors, not only on account of their first cost, but on account of the great amount of labor and time required to put them to place and remove them after the concrete has hardened. Furthermore, on account of having to recut and readjust the centering so many times to complete a modern building, it is of little value or use for other similar structures, frequently a total loss, and in some cases the contractor must pay for having it hauled from the building. Wise and progressive engineers and contractors are endeavoring to find a more suitable and permanent material, less destructible, to take its place, even though the first cost is not so low, a material which can be used over and over again, thereby producing a great saving.

The speaker has had years of experience with wood centering, and for the last ten years has had to do principally with sheet steel products for building purposes; therefore he has gained an experience with the manufacture of sheet steel that "stands him well in hand" in an attempt to adapt its use for centering purposes.

It is one thing to design a form for centering, and another to make one that is practical and that can be made on modern machinery at reasonable cost. The thing we must strive for is the minimum amount of steel and labor required to produce a

centering that will give maximum results. And this we have attempted to do by forming up sheet steel into certain standard forms so that they may be adjusted to different sized spans or bays without cutting

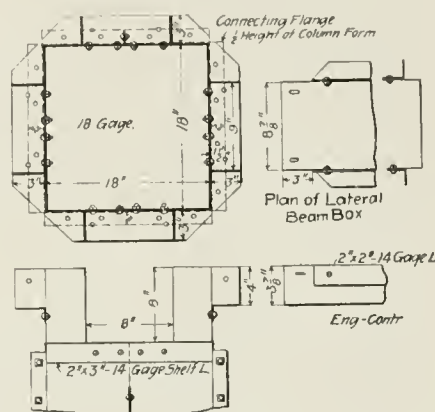


Fig. 1.

or fitting, and while we have changes and improvements to make, yet we believe we are on the right track.

The one great drawback to producing a uniform centering is the disregard of uniform spacing of columns, girders and beams for certain types of buildings, and of regulating the height of stories. It would appear that the greatest stride that could be made for the success of concrete construction would be to adopt a series of standard sizes and spacings of columns and girders for certain types of buildings. If this could be accomplished it would materially reduce the cost of all such buildings, as certain engineers and contractors would equip themselves with the necessary appliances to erect these buildings at the minimum cost; and again, other contractors would equip for other classes of buildings which seem best suited to their likings. In this way the whole field would be covered and the very best results obtained, and at the same time the investor would reap the benefit of the cost reduction.

Centering can be confined to three types, as follows:

First, the floors where the whole area interlying four columns is flat on underside; second (Fig. 1), where the area is broken up by two cross beams into three panels; and third, where the area is divided up by a series of concrete ribs or joists. In all cases the columns may be either round or square, with brackets or plain, and the carrying girders between the columns dropped below the cross beams, ribs or interlying

area. The sizes of columns and girders should be restricted to four depths and width for buildings of ordinary design, with a variation of 2 ins. in height for girders and beams, and 4 ins. for diameter of columns, 8 ins. being the minimum and 14 ins. the maximum for girder boxes, and 4 ins. the minimum and 10 ins. the maximum for lateral beam boxes; width of girders and beams in proportion to depth to be determined. Columns may range from 12 ins. to 24 ins., with 4 ins. variation, i. e., 12, 16, 20, 24 ins. These sizes could be adapted to almost any type of buildings where light or heavy floor loads are to be carried.

Again, the variation in height of stories should be restricted, allowing four different heights to apply to different classes of buildings.

Mercantile buildings can be divided into three classes, i. e., office, wholesale and warehouse; manufacturing into two, light and heavy; miscellaneous, such as schools, theatres, churches and dwellings, into two. If this could be accomplished you can readily see that it would simplify the whole matter, both for the engineer and contractor, as well as the manufacturers of centering. The engineer would determine the size of columns, girders and beams by the loads to be carried by referring to the table for certain spacings, and the contractor would only need to invest in two or three sizes of forms or centering to construct any one type of building. It would resolve itself into contractors confining their operations to certain types, which would be a good thing, both financially and structurally.

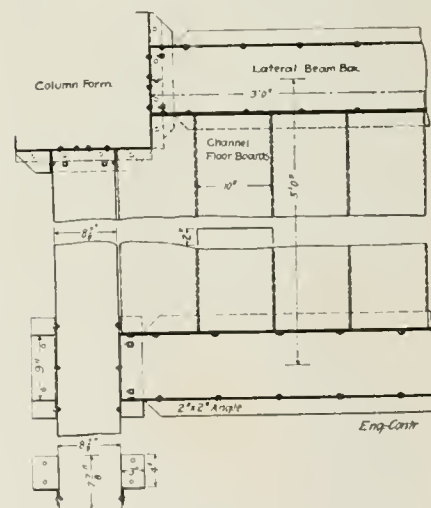


Fig. 2.

If a committee could be appointed from among the leading engineers, architects and contractors to determine upon the proper height of stories and size of columns, girders and beams for the different classes of buildings as outlined, even though they might not be able to agree upon all points relating to the different classifications, yet a step in the right direction would be taken which would undoubtedly lead to ultimate success.

Taking matters as they stand today, sheet

*Extract from a paper read before the National Cement Users' Association.
†Canton, O.

The total production of petroleum in the United States in 1907 was 166,095,355 bbls. according to the U. S. Geological Survey. This is an increase of 39,601,399 bbls. over the production of 1906.

Comparison of Reinforced Concrete and Plain Concrete Retaining Wall Construction.

BY F. A. BONE.*

The use of reinforced concrete is increasing with enormous strides but there is one direction in which it does not seem to be fully appreciated and one in which it is especially adapted; that is in retaining wall construction.

A good example of the advantages and economy is shown in the following case. A certain railway company had had two failures of a retaining wall at a certain point on its lines and had designed a very heavy gravity wall for the place, a section of which is shown by Fig. 1. Afterward a reinforced concrete wall was designed, a section of which is shown by Fig. 2.

To compare the stability of the two designs a load was assumed for the gravity

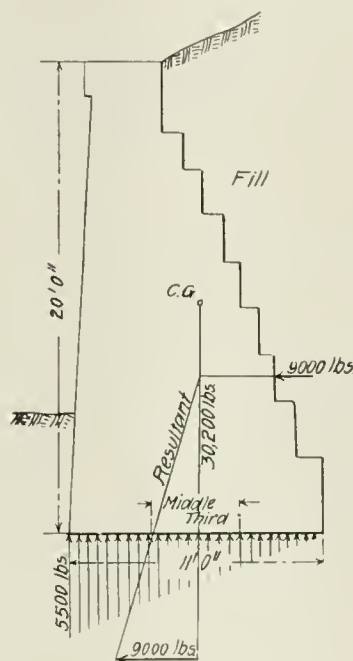


Fig. 1.

wall which caused the resultant to strike at the limit of the middle third of the base; this being the maximum load allowable under general practice for gravity walls. This load (9,000 lbs.) will cause an extreme reaction at the toe of 5,500 lbs. per sq. ft. The same load assumed for the reinforced design causes the resultant to strike at the middle of the base and therefore brings a uniform pressure over the whole base of less than 1,600 lbs. per sq. ft. (not counting the weight of earth resting on the toe). The extreme pressure on the foundation at the toe in the reinforced wall is but one-third as much as for the gravity wall and the settlement, if any would be equal over the whole base with no tendency to tip forward at the top of the wall on account of said settlement. Another, probably surprising thing, to many, regarding the reinforced

*Cincinnati, O.

design is that a settlement of the foundation (supposing it to be equally compressible over the whole base) under any load less than the maximum assumed, will have a tendency to tip the top of the wall back toward the fill.

There being considerable depth of earth in front of the wall both designs were considered amply safe as to sliding forward on the base.

The amount of concrete and steel in the reinforced design is sufficient to bear all internal stresses on a factor of 4.

The following estimates of cost per lin. ft. were made which also give an idea of the approximate saving that can be effected by the use of reinforced concrete in this line of work. The reinforced wall required $\frac{2}{3}$ cu. yd. more excavation for the toe and slightly less at the heel as it lacked 3 ins. of extending as far back into the bank as the gravity wall.

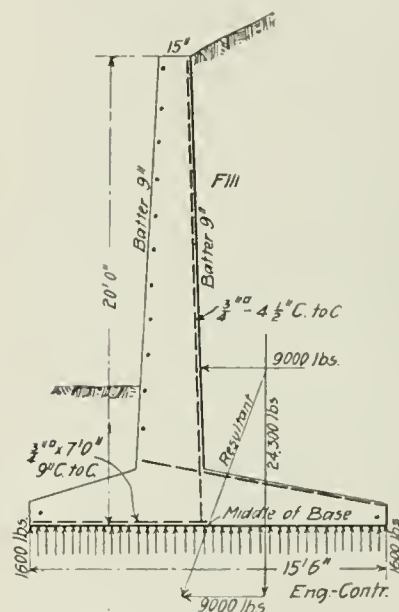


Fig. 2.

Cost of reinforced wall:

2½ cu. yd. extra excavation at 60c.	\$ 0.40
2.38 cu. yds. concrete at \$8.....	19.04
150 lbs. of steel at 3c.....	4.50

Total	\$23.94
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Cost of gravity wall:

5.49 cu. yds. concrete at \$7.50...	\$41 17
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The total cost for the forms for the reinforced wall would certainly not exceed that for the gravity wall and would likely be less.

On the above basis the gravity wall costs 71 per cent more than the reinforced wall and yet the reinforced wall has the advantage of the uniform pressure on the base under the maximum assumed load which is a condition absolutely impossible to obtain in an unreinforced retaining wall.

Cost of Constructing a Small Reinforced Concrete Girder Bridge at Hamilton, Ont.

The bridge consisted of two 9-ft. spans with rectangular center pier and wing-wall abutments. The girders were paneled and carried paneled solid railings. The structure contained 164 cu. yds. of concrete. It replaced a wooden bridge, the old piles of which were retained and used for the new foundations. Much difficulty was had in getting the foundation laid, owing to high water; under normal conditions the reduction in cost of this item would have considerably lowered the cost per cubic yard as given below. A 1-3-5 concrete was used with cement, costing \$1.63 $\frac{3}{4}$ per barrel, and gravel and sand costing \$1.85 each per cubic yard. Lumber cost \$25.85 per M. ft., B. M., and 8,000 ft. B. M. were used. The steel cost 0.275 cts. per lb. and 6,600 lbs. were used. Wages were 20 cts. per hour, and none but common labor was employed. The cost of construction was as follows:

Materials.	Total.	Per cu. yd.
Sand and gravel.....	\$ 54.30	\$ 0.331
Cement	431.00	2.627
Lumber and tools.....	195.85	1.194
Nails	12.06	0.074
Iron and steel work.....	177.71	1.083
Total materials.....	\$870.92	\$5.310
Supplies:		
Gasoline and stoves.....	\$ 15.26	\$0.094
Rubber boots	18.95	0.115
Use of roller on approaches	18.00	0.109
Total supplies	\$52.21	\$0.318
Labor	\$1,101.31	\$6.710
Grand total	\$2,024.44	\$12.335

The item of labor includes setting up forms, filling of approaches and all labor in connection with laying concrete.

We are indebted for the above information to Mr. J. R. Heddle, Assistant City Engineer, Hamilton, Ont., for which city the structure was built in 1907.

Out of the 588 locomotives now working on the railways of Roumania, 427 are using petroleum residue as a combustible. Last year 197,000 tons of petroleum residue were consumed, and the results obtained by its use are considered excellent. It is reported that the Austrian authorities who were here a short time ago to study the question of petroleum as a locomotive combustible have decided to introduce its use on the railways in Galicia.

An American peat specialist has secured an option of 450 acres of peat bog near Grand Ligne station, on the Grand Trunk railway, ten miles from St. Johns, and has begun preparing the placing of machinery, etc., for the experimental production of the peat, which, it is claimed, if properly manufactured, is superior to and a great deal cheaper than coal.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost of Excavating 654,000 Cu. Yds. of Main Canal for Payette-Boise Irrigation Project.*

The following records cover the construction of a portion of the main canal extending from Indian Creek to the reservoir, and so located that no part of the work is situated more than five miles from Nampa. The contract covers the excavation of about 654,000 cu. yds. of material. About one-half of the total amount of the work was performed by the principal contractor, the remaining portion being sublet to six different contractors.

The work under the contract was initiated during February, 1906, and was com-

The depreciation of the plant used by the contractor was figured to amount to 1.8 per cent of the total cost of the work done, and represents 33 per cent of the total value of the plant at the beginning of the work, exclusive of horses and harness. The wages of superintendents and time-keepers were included under executive, but the wages of foremen were included with the cost of labor, the labor on the contract amounting to nearly 80 per cent of the total cost of the work. Throughout the continuance of the contract labor was as a rule very scarce and the laborers employed of a poor class. During the first portion of the contract laborers worked 10 hours a day, but during the latter portion an 8-hour day

ITEMIZED COST OF EXCAVATION WORK ON MAIN CANAL

	Class 1, 467,785 cu. yds. Per cu. yd.	Class 2, 69,009 cu. yds. Per cu. yd.	Class 3, 20,303 cu. yds. Per cu. yd.	Class 4, 10,933 cu. yds. Per cu. yd.	Class 5, 85,828 cu. yds. Per cu. yd.	Overhaul, 207,074 cu. yds. Per cu. yd.
Distribution of cost						
Interest on investment.....	\$.002	\$.005	\$.008	\$.009	\$.017	\$.000
Preparatory expense	.001	.002	.004	.004	.008	.....
Plant depreciation	.003	.006	.008	.009	.020	.....
Repairs	.006	.011	.014	.017	.042	.001
General supplies	.001	.002	.004	.003	.007	.....
Superintendence	.014	.025	.031	.033	.092	.001
Grubbing right of way.....	.001	.001	.002	.001	.002	.....
Plowing	.019	.056	.058	.085	.....	.....
Drilling by hand .....	.....	.....	.057	.021	.209	.....
Explosives and drill steel.....	.....	.....	.098	.029	.225	.....
Loading, hauling and spreading.....	.089	.164	.255	.294	.507	.021
Finishing	.006	.016	.021	.032	.....	.....
Water, original cost, and hauling.....	.001	.003	.001	.001	.004	.....
Contractor's total cost.....	.143	.291	.561	.538	1.133	.023
U. S. engineering.....	.007	.016	.022	.035	.046	.001
Total cost	\$.150	\$.307	\$.583	\$.573	\$ 1.175	\$.024

pleted during March, 1908. No time was lost during the winter of 1907-08 on account of freezing weather, but the work of excavation had to be nearly all stopped during a portion of the winter of 1906-07.

The total amount invested by the contractor and sub-contractors for the conduct of the work is estimated to be \$39,836, \$28,230 of which was invested in teams and harness, the remaining portion being invested in other equipment. In estimating the interest charges the value of the horses and harness was not included, inasmuch as the horses were considered in the cost records at the current rate of wages for teams, which current rate of wages undoubtedly resulted in profit to the contractor. The cost of the contractor's bond and interest on the average amount of the monthly pay roll was added to the interest charges on equipment.

*Reprinted from the "Reclamation Record" for September, 1908.

was employed. The following current wages were paid for an 8-hour day: Superintendent, \$125 per month; time-keeper, \$100 per month; foreman, \$3 to \$4 per day; powder man, \$3 per day; drivers, \$2.50 per day; common labor, 2.25 per day; stable boss, \$67 per month.

No materials were furnished by the contractor, but considerable supplies were needed in conjunction with the excavation of rock. Coal delivered on the work cost \$9 per ton, black powder \$2 per keg, giant powder \$0.15 per lb., and lumber \$22 per M. ft. B.M.

The greater part of Class 1 excavation consisted of a stiff loam containing a considerable amount of clay with loose rocks of various sizes scattered through the mass. About one-half of this material was handled with Fresno scrapers, the remainder being handled in wheel and slip scrapers. Nearly all of the excavation was taken

from the canal prism, there being very little taken from borrow pits.

Class 2 excavation consisted of indurated material that could be plowed by ten horses. This material was usually found beneath Class 1 material, and after plowing consisted mainly of a mass of lumps of earth of various sizes. The lumps were broken by the passage of horses and scrapers over them, and were loaded and hauled by means of Fresno and wheel scrapers.

Class 3 excavation consisted of indurated material that required blasting before it could be removed, but that could be removed by the use of wheel scrapers. This material occurred locally and was found usually near the grade plane of the canal.

Class 4 excavation consisted of boulders less than one-half cubic yard in volume that would prevent plowing and the use of scrapers, and was scattered quite generally throughout Class 1 material. These boulders were usually removed by means of stone boats working in conjunction with wheel or Fresno scrapers.

Class 5 excavation consisted of boulders exceeding one-half cubic yard in volume and solid rock, requiring blasting for removal. All drilling was performed by hand and a greater part of the blasting was done with black powder, though a small amount of giant powder was used. About two-thirds of this class of material was encountered in three of the heavier cuts, the remainder being scattered along the entire length of the canal. This material was moved by means of stone boats, but horse power derricks were used, together with the stone boats, in the deeper cuts with less satisfactory results.

The accompanying table gives the itemized cost of the work.

Cost of Digging Sewer Trench and Back Filling.

The city of Holyoke, Mass., has been building a system of sewers during the past year. The main sewers are 39 in. and 54 in. These are built of concrete blocks, there being 1,233 lin. ft. of them. The sewers were built by contract, but the excavation and backfilling of the tenders was done by day labor, under the direction of the city engineer.

One trench was dug 14 ft. deep and about 4½ ft. wide, through sand and clay. The material was thrown on the side of the trench and used for back filling. The following wages were paid for an 8-hr. day:

Foreman	\$3.50
Laborers	2.00

There were excavated from this trench 2½ cu. yds. per lin. ft. The cost per cu. yd. was \$1.21, giving a cost per lin. ft. of \$2.82.

The second trench was 14 ft. deep and about 6 ft. wide, the material being the same, mainly sand and clay. There were 31-9 cu. yds. of excavation per lin. ft. The cost of excavating and backfilling this

trench was \$1.25 per cu. yd., making a cost per lin. ft. of \$3.90. All the excavation and backfilling was done by hand.

We are indebted to Mr. James L. Tighe, city engineer, for this information.

The Labor Cost of Digging a Trench and Laying Tile Drain.

In laying some tiles for the drainage of a wagon road a trench 2 ft. wide on the top and 1 ft. on the bottom, with an average depth of 3 ft., was excavated. The tiles used were 4 in. and 8 in. They were laid in the trench and broken stone placed around them, and over them, before backfilling the trench. This allows the water to enter the tiles much easier than when dirt is put around them. In all, 7,500 lin. ft. of trench was dug.

There were excavated 1,250 cu. yds. from the trench, 75 cu. yds. being rock. The rock was all in the bottom of the trench, sometimes running across the bottom, while in some places it was only found on one side of the trench. Some of it was loosened with bars and picks, but the most of the rock had to be blasted. The rock excavated was broken up by hand into about 2 in. ring stone, and was used around the tiles, very little stone being purchased for this purpose.

The wages paid on the job for a 9-hr. day were \$3.50 for foremen, \$1.35 and \$1.40 for laborers, and 75 cts. for water boys. One foreman and one gang of 16 men worked for 9 days, and the job was completed by 2 foremen and 26 men, working 10 additional days. The total labor cost for excavating the trench, breaking up the stone, laying the tile, and placing broken stone around it, and backfilling the trench was \$674.15.

The tile laying was done by one man and an assistant, who wheeled the tiles and laid them alongside of the trench, the tile layer then placing them. These two men, in a half day, could lay tiles in the trench that the entire gang had dug during a day. After they had laid the tiles, with the assistance of a few additional men, they did the backfilling of the trench. The labor cost of placing the tiles was \$26.14, making a cost of 35 cts. per lin. ft. The cost per lin. ft. for excavating, breaking rock and backfilling was 8.6 cts., making a total cost per lin. ft. of the completed drain of about 9 cts.

The cost of excavating and backfilling per cu. yd. was 52 cts.; this includes the rock work.

For comparative records of cost see Gillette's "Handbook of Cost Data," page 454 et seq.

The grand total of excavation on the Isthmian Canal during August was 3,252,506 cu. yds., all of which, except 100,035 cu. yds., was taken from the Canal prism. There were 26 working days in August. Of the grand total of August excavation 1,876,515 cu. yds. were dry excavation and 1,375,991 by dredges.

Testing a Powder Blast Before the Explosion.

In blasting rock today for construction and quarry purposes, electrical exploders are used quite extensively, the charges being put off in series by a battery. For one reason or another a great many mishaps and other blasting mishaps occur in this method of blasting, much more so than with tape fuse and exploding caps. Such mishaps are not only provoking and expensive, as the workmen are kept from their work while the trouble is being located, but at times, accidents occur that either injure or kill some of the men.

We illustrate in this article a small instrument known as "The Blaster's Friend," which is used to test exploders. This instrument readily fits in a man's coat or



Exploder Testing Apparatus.

pants hip pocket. At one end there are two metal buttons, near which is a little glass dial. In the other end is a sensitive silver battery. In testing an exploder the two wires are held, one against each button, and, if the exploder is in good condition, a small hand, like the hand of a clock with O K marked on it, appears at the glass dial, thus signifying that the exploder is all right for use. If the exploder is injured in any way so it will not explode, the O K hand does not appear. The operation is simple.

By means of this testing instrument each exploder can be tested before being used, and if the wires of the exploder are lengthened it can again be tested after it is placed in the hole and before the latter is tamped up. After the holes are

all connected and the lead wires attached, and before connecting the exploding battery, the entire circuit can be tested by the Blaster's Friend.

By this series of tests as the holes are being loaded, a defective exploder is discovered, likewise an imperfect wire connection, or if the circuit is grounded it is discovered before the blast is attempted. Every contractor and powder man will see the advantage of such a testing battery that is easily carried and handled.

The Blaster's Friend is sold by the New York Blasting Supply Co., 11 Broadway, New York. The price is \$5, net.

Some Drilling Records and the Cost of Maintaining Drills.

In driving a tunnel 7 x 12 ft. 2,000 ft. long in the Pine Brook Mines of the Scranton Coal Co., at Scranton, Pa., two 3-in. Wood drills were used. These drills have a stroke of 6½ ins. and will drill to a depth of from 10 to 14 ft. The drills were worked in 8 hr. shifts. The average depth of hole driven by each machine in one shift was 127 ft., thus drilling nearly 16 ft. per hour. The tunnel was through the hardest rock that is encountered in mining in these coal fields.

The work was hard on the drills, yet the cost of maintaining them for the entire tunnel excavation was small. For the two drills the total amount spent for repairs and renewals was \$15.95. This money was spent for the following: Two feed screws with nuts complete, 12 sets of piston packing, 6 sets of piston ring springs, 6 dozen ratchet springs and 2 dozen chuck bolts. It will be noticed that the parts renewed are about the only parts of a well made drill that wear out under ordinary conditions. No other parts of the drill, we are informed, shared any wear from the work they did. This gives a cost for maintaining one No. 3 drill of about \$8 for drilling for the excavation of 3,100 cu. yds. of rock from the tunnel, the number of feet drilled per cubic yard of rock excavated being much more than in open cut work.

The No. 3 wood drills have been found to do excellent work, by the Scranton Coal Co., in shaft sinking in what is termed "blocky ground," that is alternate layers or strata of soft and hard material. This company mines some coal from veins that are from 2½ to 3 ft. deep. It is necessary in this work either to blow the roof down or take the bottom up. This work was formerly done by hand, and in 8 hrs. two men seldom drilled more than 2 ft. of roof. Now the company uses No. 2¼ Wood drills, with two men to each drill. These drill men move from room to room as they are needed and drill from 60 to 75 ft. of hole in 8 hrs.

We are indebted to Capt. B. S. Phillips, superintendent of rock work for the Scranton Coal Co., for the information given above. He states that these records, including repair costs, are average records that are maintained on all of their rock work.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Asphalt Plant of Toronto, Ont.

The following description of the asphalt plant built in 1907 by the city of Toronto, Ont., is taken from the annual report of the City Engineer, Mr. Chas. H. Rust:

During the year the contract for the construction of an asphalt plant, of a capacity of 1,500 sq. yds. per day of nine hours, was awarded to the Warren Asphalt Paving Co., of Boston, Mass. The amount of the contract was \$28,575.

The buildings containing and enclosing the plant are built of steel, the walls and roofs are covered with galvanized iron, and the floors are of reinforced concrete. The plant consists of:

Two self-contained rotary driers, manufactured by Warren Asphalt Paving Co., the revolving cylinders being 40 in. diameter and 19 ft. 6 in. long; draft is supplied by a 50-in. exhaust fan which discharges into a Cyclone dust collector; the driers are fed by two chain elevators and the hot sand or stone is discharged into an enclosed elevator and conveyed to steel storage bins (capacity 10 cu. yds. each), situated on the second floor, the stone bin being fitted with a rotary screen. There is also a storage bin for limestone dust provided on the second floor, having a capacity of 4 cu. yds. and fed by a dust elevator. The hot material and the dust are drawn by gravity into their respective weighing boxes which discharge into the mixer; the mixer has a capacity of 1,100 lbs. of topping mixture.

The asphalt cement is prepared in three enclosed melting tanks provided with mechanical agitation and having a capacity of 2,000 Imperial gallons each. The asphalt cement is elevated by air pressure to the asphalt weighing bucket running on an overhead trolley to the mixer.

The storage tank for flux has a capacity of 10,000 Imperial gallons. The flux is blown from it to the weighing tank on the first floor and drawn by gravity into the kettles.

The asphalt barrels are hoisted to the charging floor by a barrel elevator. Power to the main portion of the plant is supplied by a 10 x 12 in. automatic cut off centre crank engine, manufactured by the Erie Engine Works, and to the agitating tanks and barrel elevator by a 5 x 5 in. vertical automatic cut off engine, manufactured by the Sturtevant Blower Works. Compressed air used for forcing the asphalt cement out of the tanks and for other purposes is furnished by a 6 x 8 x 12 in. Knowles direct acting air compressor. Steam is supplied to these engines by a 60-hp. Star water tube self-contained boiler. Street and plant tools, including an 8-ton and 5-ton steam

asphalt rollers, five wagons, hand rollers, pitch kettles, etc., and 12 Wilkinson asphalt dump wagons, complete the equipment.

The plant was taken over by the city on Oct. 1st, but owing to the non-arrival of the roller fittings the plant was not put into operation till the end of that month. During the remainder of the season three small pavements were laid, viz., Seaton square, 2,256 sq. yds.; Berti street, 459 sq. yds.; Ryerson avenue, 313 sq. yds.; total 3,028 sq. yds. asphalt, California asphalt being used.

During the coming year the city expects to be able to do all its repair work and probably a few streets. This, it is thought, will result in reducing the number of complaints which are constantly received, owing to the number of openings made in the different streets, especially in asphalt pavements, not being promptly repaired

A 25-Foot Steel Tape in a 2¼-Inch Case.

A neat little steel tape, which is conveniently carried in the pocket, has been sent to this office by the manufacturers, Keuffel & Esser Co., of New York. The steel ribbon is only ¼ in. wide, and the case that holds it is only 2¼ ins. diameter. The tape is 25 ft. long, divided into feet, tenths and hundredths. The trade name applied to the tape, "Liliput," aptly describes it. A feature worthy of comment is the dark finish that is given to the tape, which causes the bright graduations to stand out very clearly. The finish is also claimed to prevent rusting, and thus does away with the necessity of greasing the tape.

An enumeration of the population of the Isthmian Canal zone was begun on March 3 last and completed on June 23. According to this census the total population of the Zone is 50,003. Of this number, 24,963 are employed either by the Isthmian Canal Commission or the Panama Railroad Company. Of the total population 14,635 are white, 34,785 are negroes, and 583 are Chinese. Of the total white population, 6,863 persons are from the United States. The total cost of the work, including the wages of enumerators, the cost of stationery and printing, the cost of tabulation, and the cost of supervision in the Executive Office, was \$3,936.36, an average cost per person enumerated of 7.87 cts.

The Ontario Hydro-Electric Commission is shortly to commence the construction of its high-tension transmission line from Niagara Falls to Toronto.

Up to Aug. 31, 1908, New York City had spent \$54,802,944 in constructing rapid transit subways.

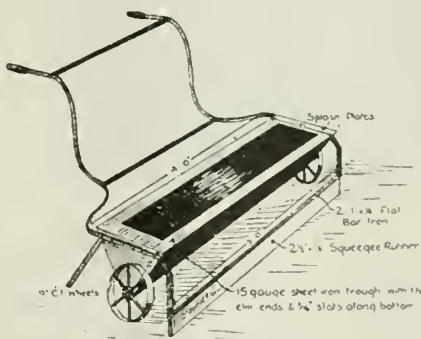
Methods and Costs; Some Old; Some New.

Lighting a Cableway.—On one of its construction jobs the Great Lakes Construction Co., of Buffalo, N. Y., has been using a Milburn light on its cableway plant, where the towers are 600 ft. apart. The generator was placed on a platform and the reflector was placed at the top of the head tower, 70 ft. above the platform. The ray of light was thrown along the main cable so that the operator had no trouble in seeing all of the carriers that were necessary. Another light was used on a revolving excavator machine, the light being so mounted that it revolved with the machine, the rays of light being concentrated on the bucket at all times. The cost of operating each light was about 50 cts. per night.

Steel Plate Girder Bridge Construction.—In the work of abolishing grade crossings at New Bedford, Mass., the New York, New Haven & Hartford R. R. has put into effect a somewhat new departure in the design of its bridges. The railroad is to be carried over Deane, Sawyer, Coggeshall, Cedar Grove, Weld and Logan Sts. by steel plate girder bridges, carrying three tracks, and over Wamsutta St. and Acushnet Ave. by the same type of bridge carrying four tracks. The girders of these bridges are carried upon steel columns set in the sidewalk just inside the curb line and not upon the abutments, with the exception of the bridge over Acushnet Ave. Only the track stringers rest upon the abutments. The columns are set on concrete piers, whose foundations are 7 ft. square for all except the Acushnet Avenue bridge, where they are 8 ft. square. The tops of the piers are at the grade of the sidewalk. These bridges have open floor systems, but the ties are to be covered with 2-in. plank to prevent ashes, oil, etc., from dropping on the street below. As an additional protection to pedestrians, a canopy is to be built over the sidewalks the full length of the bridge.

Lining a Broken Reservoir.—The city of Niles, O., has a reservoir 70 ft. in diameter and 17 ft. in depth, built in rock, which gives a solid rock bottom and rock sides to an average height of about 6 ft. From that point to top it was built of stone masonry and lined with a 4-in. brick wall from the bottom to the top. Adjoining the reservoir is a stone quarry about 40 ft. deep and about 20 ft. from the reservoir at the nearest point. The reservoir wall became cracked, partly from blasting in the quarry and partly from the action of the weather, with the result that no water could be kept in the reservoir above a depth of 5 or 6 ft. To repair the reservoir it was decided to build an 8-in. concrete wall inside after taking out the 4-in. brick wall; the new wall to extend from the rock floor to a height of 17 ft. Atlas Portland cement,

good, clean bank sand and clean limestone broken to pass a 1½-in. screen were used in making the concrete. The concrete was thoroughly mixed and proportioned approximately as follows: 1 part cement, 2 parts sand and 4 parts stone. The concrete was reinforced with rods so as to give it strength enough to stand without support from the old wall. For the vertical reinforcing ½-in. bars spaced 2 ft. on centers were used; and for the horizontal reinforcing ½-in., ¾-in. and 1-in. bars forming circular rings 8 in. on centers were used. The horizontal rings were made continuous by lapping consecutive bars as follows: The 1-in. bars were lapped 36 ins., the ¾-in. bars were lapped 30 ins. and the ½-in. bars were lapped 22 ins. The



Road Tarring Machine.

joints were so arranged that they do not lie in the same vertical plane. One-half inch vertical bars were put in at 2-ft. intervals. The estimated cost of the work was \$2,000.00; the bid on the work was \$14.25 per cu. yd. for concrete, which included the inside shoring, the old wall being used for the outside shoring. The lump sum for the rods was \$600, making the total about \$1,900. The work was described by Mr. Wm. Wilson in the Proceedings of the Ohio Engineering Society from which the above note has been taken.

"Home Made" Road-Tarring Machine.—The accompanying illustration shows a small and inexpensive machine for tarring roads. The machine has no intricate working parts, and is drawn by one man. It is capable of tarring a width of 5 ft. at one stroke and will do half a mile of 24-ft. road in one day, with the following force: One man using machine, two men feeding with tar and generally assisting, one man tending tar boiler. The principle of the machine is as follows: The V-shaped trough is provided with slots 1-16 in. wide, which allows the tar (which is poured in from buckets) to percolate to the road, and is followed by a rubber squeegee which spreads it. The quantity of tar on the road is regulated by raising or depressing the handles of the machine, thereby increasing or decreasing the pressure on the squeegee. The surplus tar is formed in a ridge at the end of the squeegee and

spread by the next stroke of the machine. The advantage of having slots in the trough instead of holes is that the former can be cleaned by an old table knife. A local blacksmith can make one of the machines for about \$15. The machine was devised by Mr. Wm. Augustus Farnham, Assoc. M. I. C. E., of Sidecup, Kent, England, and is described by him in a recent issue of *The Surveyor*, from which the above note has been taken.

Cost of Cleaning Sewers and Catch Basins.—The following tabulation shows the amount expended per mile per year for the past 21 years by the Bureau of Sewers of Chicago, Ill., in cleaning sewers and catch basins:

	Miles of Sewer to Maintain.	Cost of Cleaning.	Cost Per Mile Per Year
1887....	474	\$ 50,264.65	\$106.04
1888....	492	52,423.41	106.55
1889....	712	61,503.01	86.38
1890....	785	107,878.34	137.42
1891....	888	123,620.44	139.21
1892....	992	142,720.52	143.87
1893....	1,145	132,633.51	115.84
1894....	1,211	154,225.45	127.35
1895....	1,248	134,424.44	107.71
1896....	1,306	96,901.65	74.20
1897....	1,345	91,414.89	67.96
1898....	1,388	92,961.88	66.98
1899....	1,424	72,439.07	50.92
1900....	1,453	80,985.64	55.73
1901....	1,475	94,369.87	63.98
1902....	1,501	99,372.58	66.20
1903....	1,529	118,303.41	77.37
1904....	1,583	124,260.26	79.50
1905....	1,615	127,003.97	78.64
1906....	1,633	150,942.10	92.43
1907....	1,673	204,329.37	122.13

The work is done by regular employees of the Bureau of Sewers, common laborers during 1907 receiving \$2.50 and up per 8-hour day.

The total force of employees, whites and blacks in the Isthmian Canal Zone during the last fiscal year, ending June 30, averaged 43,057, and among these there were 789 deaths, a death rate of 18.32 per thousand, states the Canal Record. During the previous year, with an average of 32,324 employees, there were 1,272 deaths, a death rate of 39.41 per thousand, or more than double that of the year just closed. The total white force during the last fiscal year averaged 12,058 men, with a death rate of 15.34, while in the previous year with an average force of 7,727 it was 15.93. About one-third of the deaths among the whites were due to accidents and violence of various kinds, reducing the death rate from disease to about 10 per thousand. Of the 12,058 white employees, 5,035 were Americans and among these there were 41 deaths, 27 from disease and 14 from other causes, making the death rate from disease among them 5.35 per thousand. The families of white employees averaged in numbers 2,005, and among them there were 18 deaths, a death rate of only .897 per thousand.

English Methods of Tree Planting in Streets.

At the conference of Engineers and Surveyors at the recent annual convention of the Royal Sanitary Institute of Great Britain, two papers on the planting of trees in streets were read. One of these was by Mr. C. Chambers Smith, engineer and surveyor to the Sutton Urban District Council, and the other was by Mr. W. W. Pettigrew, superintendent of the Parks Department of Cardiff.

In his paper Mr. Smith stated that it had been found by experience that the best practice is to plant the trees 30 ft. apart and to place them within about 9 in. from the back of the curb. Excavations are made in the path, 2 ft. wide, 3 ft. long and 2 ft. to 3 ft. in depth. Carefully selected mould with the addition of a little stable manure is placed in this excavation to within 9 in. of the surface. The tree, which should have roots with plenty of fibules to ensure successful growth, is planted in the center of the mould and the soil well rammed around it.

The use of iron guards to surround the trees is considered by Mr. Smith as being objectionable, and all that he has found necessary is to provide a support for the young tree against winds by means of a stout larch pole, about 14 ft. long. This pole is driven well into the ground and the tree secured to it by means of wire wound round it. In order to preserve the young trees from injury by boys lacerating or stripping the bark and also to protect them against the gnawing of horses, Mr. Smith uses galvanized wire netting of 1 in. mesh, wound twice around the tree and the supporting pole attached to it to a height of 6 ft., the ends being secured by wire. Mr. Smith considers the best time for planting trees as being between the end of October and the beginning of March. In the selection of trees for planting care should be exercised to select such trees as will suit the soil in which they are to be planted. In Sutton part of the district comprises chalk soil and part clay and trees, such as pines, which thrive luxuriously in clay cannot be made to grow in chalk soil, and limes, which are very successful on chalk, will not thrive on clay. Mr. Smith states that he has found the following trees answer on chalk soils: limes, horse chestnuts, beech, sycamore, Norwegian maple and Camperdown elm—while on clay soils the plane, sycamore, horse chestnuts, maple and Camperdown elm have been extensively planted. Care is, however, taken to plant different varieties alternately, and not to have one variety running along any street.

In specifying for the supply of trees Mr. Smith requires that the circumference of the stem at the ground level shall not be less than 7 in., and that the lowest branch must be at least 7 ft. from the ground level, while the roots must show healthy fibrils as distinguished from tap-roots. As the tree grows the lower branches are

lopped until the lowest branch is not less than 10 ft. from the ground.

The cost of planting the trees, as given in Mr. Smith's paper, is about as follows:

Supporting-poles	\$0.30
Trees	.72
Wire	.24
Soils, manure, labor and cartage.....	.84

Total per tree\$2.10

Mr. Pettigrew in his paper states that in planting trees in public streets, it must always be borne in mind that the conditions under which they are to be grown are perfectly unnatural, and that their treatment must be in keeping with their artificial surroundings. Instead of permitting them to develop into timber or spread out their branches as far as they can, it is the object of those who have care of them to restrict their growth and expansion as much as possible, and so keep them within bounds. To carry out this—entailing as it invariably does an annual pruning—adds considerably to the upkeep of street trees, hence it is a wise economy to use fastigate forms wherever they are suitable.

Regarding the practical detail of tree planting Mr. Pettigrew has the following to say:

"Trees bearing stunted growths (unless planted with a direct object) should never be used, for the conditions under which they must necessarily be grown in streets is not conducive to their growing out of any such defects. Free growing, clean, healthy trees are the best to plant under all circumstances, but more especially is this so in the case of street planting. Again, trees for this work should be planted as early as possible after the fall of the leaf, so that the soil immediately around their roots may be enabled to get the full benefit of all the winter rains. When the soil on the site where a tree is about to be planted is not good, it is in the long run the best economy to clear it out and put in fresh loam. Whenever and wherever possible iron gratings should be used for covering over the soil about the roots in preference to paving stones or even gravel. The use of gratings enables moisture and air to reach the young roots, without which it is quite impossible for trees to flourish.

"In addition to providing newly-planted trees with adequate support, it is invariably absolutely necessary to protect the stems from damage. It is the provision of this protection, together with the iron gratings just alluded to, which makes tree planting the expensive undertaking it usually is.

"In quiet country towns trees are sometimes sufficiently protected by means of three stout stakes placed at equal distances around and at about 18 in. from the base of the stem. These are joined together at about 5 ft. 6 in. from the ground, and the point of attachment used as the support to which the tree stem is securely fastened. Such a cheap form of protection cannot be turned to account in many towns, hence the

necessity for providing iron tree-guards, which cost anything from \$3.60 to \$8.40 apiece."

Mr. Pettigrew states that they have never found it wise to plant any tree under 10 ft. in height, nor with less than 6 ft. of clear stem. It has also been found best to never allow a permanent branch to develop from the tree until there is at least a clear stem of 12 ft.

Cleaning Cast Iron Water Pipe at Cincinnati, Ohio.

Cincinnati, O., is taking steps to secure the cleaning of the cast iron mains of its water distribution system and on Sept. 1, opened bids for a considerable amount of this work. The approximate estimate of the quantities of work as made by J. A. Hillar, Superintendent of Distribution was as follows: 6 in. pipe, 2,725 ft.; 8 in., 14,440 ft.; 10 in., 48,380 ft.; 12 in., 380 ft.; 16 in., 12,000 ft.; 20 in., 14,870 ft.

The National Water Main Cleaning Co. was the only bidder, its prices per lineal foot for cleaning the pipe complete being as follows:

	If all work in schedule is awarded.	If between 75 & 100% of schedule is awarded.	If between 50 & 75% of schedule is awarded.
4-in. pipe..	\$.025	\$0.25½	\$0.26
6-in. pipe..	.25	.25½	.26
8-in. pipe..	.23	.24	.25
10-in. pipe..	.23	.24	.25
12-in. pipe..	.35	.35	.35
16-in. pipe..	.34	.35½	.37
20-in. pipe..	.36	.38	.40
24-in. pipe..	.40	.41	.42
30-in. pipe..	.42	.43	.44
36-in. pipe ..	.45	.45¾	.46

The specifications provide that the prices paid per foot for cleaning the cast iron pipes shall be in full compensation for the pipes, special pipe castings, valves and service branches cleaned, ready for use; including all lead and other materials, all tools, labor transportation, trenching, bailing and pumping, shoring, cutting and re-connecting of pipes, furnishing and placing pitometers street connections and curbs and covers and the backfilling and ramming of trench; the furnishing and handling of pipes and special castings; reconstruction of all road and street paving sidewalks, crosswalks, gutters and curbs disturbed in cleaning of pipes, the supporting and protecting all culverts, sewers, catch-basin connections, gas and water pipes, electric conduits and fixtures, and all house connections to the same, and the support of railroad tracks; the cost of pitometer tests; the disposition of surplus material excavated; the removal of material removed from pipes, the protection of travel in thoroughfares, the maintenance of the work done until it is finally accepted and paid for, and all other work necessary or incidental to the cleaning of the pipes, complete in the manner specified.

It is further provided in the specifications that the pipe shall be cleaned by machine

or appliances capable of removing all rust, tubercles, organic growths, deposits, silt and other foreign material from the interior of the pipes. As many passages of the machine shall be made as is necessary to thoroughly clean the interior surface. After the final passage of the machine the pipe shall be thoroughly flushed to remove all remaining loose material.

To determine the thoroughness of the cleaning tests are to be made with pitometer. This test must show an efficiency of flow equal to 95 per cent of the quantities given by the formula: $Q = A \times C \times D^2 \times S^{0.54}$, in which Q = discharge in cu. ft. per second; A = area of pipe in sq. ft.; D = diameter of pipe in ft.; S = ratio of head to length; and C = 55 for 4, 6, 8 and 10-in. pipe, 60.5 for 16 and 20-in. pipe, and 66 for 24, 30 and 36-in. pipe.

Tar-Lithic or Tar Concrete Pavement.*

BY WILLIAM B. CLEVES.†

Although the petrolithic method of road making has passed the experimental stage in California, where its superiority and economy have been abundantly demonstrated during six years' use upon a wide variety of soils and under greatly varying conditions, it has not hitherto been introduced in the Atlantic states.

This may be due to the conservatism of our road makers, who still cling to macadam, although the havoc made upon fine stone roads by motor vehicles should have led ere this to a trial of any method of road building which promised greater durability.

Having been called upon, in 1907, to advise upon the making of a road which, fulfilling ideal conditions, should be handsome, durable and inexpensive, I looked up the record of petrolithic road making in the Pacific states and became convinced that if such roads could be made on Long Island we need look no further.

The chief obstacle found was the cost of transportation of crude oil from California and of the installation of the new tamping machine there employed.

The petroleum from southern California oil fields is rich in asphaltum, while that found in Pennsylvania, Ohio and West Virginia contains little or no asphaltum, but contrariwise carries a large percentage of paraffine, which is a lubricant and not a cementing substance.

We of the east have, however, in coal tar a substance which appears to be superior to asphaltum in its cementing quality, inasmuch as it contains no inert or antagonistic materials. This applies only to pure coal tar, however. Crude tar as it comes from gas works or coke ovens contains ammonia in quantities sufficient to impair its adhesive quality, inasmuch as it will in time cause it to crumble.

In tarvia, however, which is a purified

tar, of standard viscosity, I believed that we should find a substitute which at lower cost might prove of even greater value than California asphaltic oil.

Acting upon this belief I laid the experimental piece of pavement shown in the accompanying illustration, in August, 1907, on one of the boulevards of the Laurelton Land Co., at Laurelton, L. I., using the petrolithic method of tamping and tarvia "A" as the cementing material.

The roadbed was of sand, upon which had been spread about 2 ins. of gravelly



Tar-Lithic Pavement at Laurelton, L. I.

loam. This was plowed to a depth of 6 ins. and harrowed. The tarvia was heated in an open tar kettle—no record of temperature being made—and poured over the ground as evenly as possible, one gallon to each square yard. This was thoroughly mixed with the soil to the depth of 6 ins. with a cutaway harrow, followed by a spike tooth harrow. A second application of 1 gallon per square yard was then made and harrowing repeated, and a third application of 1 gallon in the same manner. The contour of the road was then made uniform by raking and a fine combing given to the surface with a lap-plank float thickly studded with wire spikes, after which the road was tamped with a tamping roller until the whole body of tarred soil was thoroughly compacted and the tamper feet rode upon the surface.

No road machine being available, a final leveling was done with rakes and the pavement finished with a 3-ton road roller.

This pavement presents the appearance of asphalt in which fine gravel is embedded. Within one week from completion of the road heavy loads of gravel were being hauled over it. Ten months of such use finds it uninjured, with no ruts or depressions. It is so hard that it does not give perceptibly under heavily loaded tracks, but it has sufficient resiliency to ride as easily as asphalt under a rapidly moving vehicle. It does not soften under summer heat nor was it affected by floods or frost. It is inodorous, noiseless, dustless, mudless; does not soil shoes or clothing, and is not slippery when wet. So far the road has met all expectations, and has been approved for use at Laurelton, Senator Reynolds' residential park in Greater New York, where about 12 miles of the pavement will be laid. It will, I believe, become speedily popular.

The cost of this tar-lithic pavement can hardly be determined closely by so limited an experiment, but it is surely less than that of macadam of like thickness.

After the completion of this pavement a water main burst under it and blew out a hole 6 ins. in diameter. This break was readily mended; its outline is faintly shown in the left foreground of the illustration.

As I have not seen a petrolithic road made with California oil, I cannot make comparison between the two in appearance and wearing quality. The oil is certainly

more easily applied and if a supply can be had in the east which carries a uniform percentage of asphaltum and at low enough price it may be found advantageous to use it.

The second experimental dam at Gatun on the Isthmian Canal has been finished and 85 ins. of water has been turned on to the south, or upstream toe. This represents the 85-ft. head against Gatun Dam, as the experimental dam is on a scale of 1 to 12. Sand was pumped into this dam from both the upstream and downstream toes, with the result that the finer particles of silt were deposited about half-way between the toes, forming a core of fine impervious material at the center of the dam. Although the experiment is not completed, the progress so far made shows that the seepage through this dam becomes regularly less as the water advances toward the center, until it is almost nothing at the core. In the first dam the material was pumped in from the downstream toe, the result being that the very fine particles of earthy material, which are most impervious to water, were deposited along the upstream face. A head of water 85 ins. deep in the experimental dam, was applied to the upstream face of this dam May 14, and the experiments were continued until a constant rate of seepage had been maintained for a week. The material is sandy clay, and in the construction of the first experimental dam, much of the finer impervious material was lost in the water that drained off, and yet the deposit on the upstream face was very water-tight. The remainder of the material arranged itself in such a way that, although offering great resistance to percolation, any water which penetrated the upstream face drained off readily, and the line of saturation was kept very low.

*Reprinted from August, 1908, Good Roads Magazine.

†Queens, Long Island.

LETTERS TO THE EDITORS.

Methods of Cellar Excavation.

Sirs: I would be pleased to see you publish descriptions of any improved means of excavating cellars or excavations below grade, where quantities might be anywhere between 1,000 and 5,000 cu. yds. of earth, cemented gravel or very soft sand.

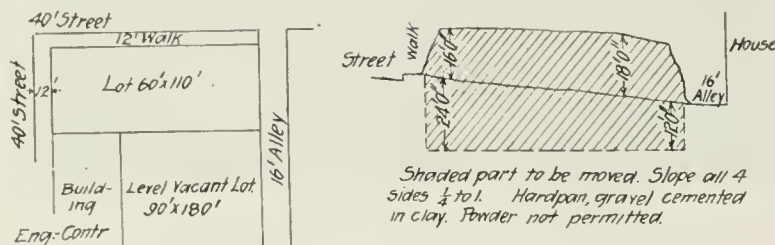
I submit an actual case in this sketch.

Will you please suggest some method of making this cellar excavation?

Yours truly,

CONTRACTOR.

[We have published a number of articles in ENGINEERING-CONTRACTING on cellar excavation, and shall be pleased to give addi-



Plan and Section of Proposed Cellar Excavation.

tional information on the subject as we obtain the data.

We would suggest to our correspondent that the job he presents could be done economically by means of a steam shovel of the revolving type, loading into dump wagon. There are several manufacturers that make this style of shovel, which is well adapted to working in confined areas. In our issue of April, 1906, page 107, there is an account of a Thew shovel equipped with a $\frac{5}{8}$ cu. yd. dipper digging cellars in New York city. Also in our issue of April 15, 1908, an account is published of a Browning steam shovel, adapted from a locomotive crane digging a cellar. Records of costs are given in these articles showing a cost of excavating and loading wagons varying from 3 to 8 cts. per cu. yd.

These figures can be compared with excavating cellars by hand with pick and shovel, for in our issue of March, 1906, page 63, the detail cost of such work is given, showing a much higher cost for excavating and loading.

A locomotive crane will also be found adapted to such excavation. A clam shell or orange peel bucket will be necessary with the crane, and the crane can be afterwards used for handling building materials.

Another method of digging cellars that has been used successfully in New York city, where the excavated materials are carried away on scows, is to do the excavation with wheel scrapers, and where the distance to the scows is not great, to transport the earth by means of belt conveyors, the scrapers dumping through traps on to the conveyor. At other times wagons are loaded by means of traps and scrapers.

In Omaha some cellars for large buildings have been excavated by means of the

hydraulic giant, the earth being sluiced into a city sewer and thus carried away to the river. In Seattle this method is being used to regrade a large part of that city. Various articles have been published in this journal showing costs of this work, and in many cases the plant necessary was a small part of the cost, thus allowing, when conditions will permit, of this method of excavation being used for comparatively small yardage.—Editors.]

A Method of Checking Levels.

Sirs:—I note in your issue of August 19, page 122, a method of checking levels, in which Mr. Tate gives the following:

1st H.I.—last H.I.=D₁.

1st Elev.—last Elev.=D₂.

1st B.S.—last F.S.=D₃.

D₁—D₂=D₃.

That this equation may still hold true and all the operations not be correctly done will be readily seen by using his own sample page:

B.S.	H.I.	F.S.	Elev.
3.250	103.250 (350)		100.000
0.250	102.250 (300)	1.250	102.000 (230)
2.070	101.200	3.120	99.130 (140)
		3.160	98.040

The figures in parentheses are nine, and suppose that an error of 0.1 has been made in calculating the 2nd H.I. and this difference carried through to the end. D₁ will then be 0.1 too small, but D₂ will also be 0.1 too small, and their difference will remain the same; the check equation will still work out, though the final elevation is in error 0.1. Investigation will show that as long the first H.I. is correct and the last elevation corresponds correctly to the last F.S., there may be any number of intermediate errors in both the H.I. and Elev. columns.

Very truly yours,

MALCOLM ELLIOTT.

Ancon, Canal Zone, Sept. 1, 1908.

Concerning Compression Members.

Sirs—Nature affords some examples of compression members.

The sugar cane, for instance, is one of nature's own tension and compression members of circular section, provided with diaphragms at intervals from end to end.

The trees are circular struts subject to combined lateral and vertical stress. From

whatever direction the pressure comes, the side subjected to compression is a semi-circular arch.

Many years ago, cogent arguments were used by men in the front rank of the profession, in favor of open as compared with closed compression members. These arguments may be considered as good today, as when first made, for members less than a certain size, but if applied to very long spans, have less *raison d'être*, such spans admitting of main members large enough to be entered at intervals by reinforced openings for purposes of repairing, painting, etc.

Such compression members require no lattice work. Their four sides may be closed and be perfectly similar and symmetrical about their axis; or if circular, of uniform thickness all around. In both cases they could be fitted with inside diaphragms, having reinforced openings, sufficient for one man passage, with smaller openings, at shorter intervals, to furnish some light and ventilation. In designing compression members, it is convenient to decide first, what unit stress is to be used,

and to fix the proportion of — accordingly

To illustrate, say that a flat ended compression member, whose section is a square with four similar sides of equal sectional area, is 100 ft. long, subject to pressure of 2,000,000 lbs., with a unit stress of 15,000 lbs. per sq. in.

In a table of steel compression members (l being feet and r inches) find under the

head of — and opposite the No. 3, the nearest entry to 15,000 lbs., — = 33½ ins., is

the radius of gyration and 21½ × 33½ is nearly enough the proper breadth of side of a square compression member, or almost 7 ft. Under favorable circumstances each one of the four sides would bear pressure of 500,000 lbs. dead weight being neglected for present purposes. It is worthy of consideration whether any, and if so, what further allowance should be made. Take the case of a large structure with north and south axial direction and east and west exposure. Its sides are alternately exposed to the sun, and one side of a continuously built compression chord, being so exposed, the tendency is to produce curvature that causes stress upon the chord and its lateral connections, difficult to define in figures. Ten degrees difference of temperature between an inner and outer plate held by the same rivets in a length of 1,430 ft., would be sufficient to shear the heads of two ¾-in. end rivets half through. The same thing takes place for days in succession, and the cumulative effect is still more difficult to estimate. The climate again has to be considered. Experiments made with good bar iron (see record in Trautwine's Pocket Book) at 23° F. or only 9° frost, indicate an average loss of strength of 3¼%. There

are, however, within the limits covered by North America railway lines places where 50° of frost during the winter is not uncommon, but we do not know what loss of strength such a temperature may entail.

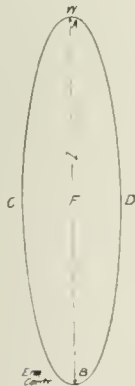
All things considered it would seem to be safe and reasonable to assume that there are times when one side of a column must do duty or the side opposite also, and that the safe working unit of stress should not be more than half the elastic limit, all of which is covered by the 15,000 lbs. unit, except the temperature and climatic effects, to compensate for which, it would be advisable to still further reduce the aforesaid 15,000 lbs. stress unit by about 25 per cent, making it 11,250 lbs., being probably not far from the fourth part of the ultimate strength of the member to be designed. If this compression member instead of being built closed (as it might be with lateral dimensions of 7 ft.) had its proportions modified so as to require two opposite sides to be latticed and tie plated: whatever sectional area was given to the web sides, would regulate the size of the end lattice and tie plates. Let each web side be proportioned to sustain a working pressure of 1,000,000 lbs. and suppose this member to be laid down horizontally as a beam with ends supported, the web sides being above and below, what uniformly distributed load should be put upon it to produce flange

H'

stress of 1,000,000 lbs.? Now $\frac{H'}{8d} = 1,000,000$

000 lbs. $\therefore H' = 560,000$ lbs., the end shear of which equals 280,000 lbs. and indicates the sizes to be given to the end lattice and tie plates in order to produce uniform strength. The 7 ft. depth is here supposed to suit the centre of gravity of the flanges, but this is immaterial for a supposed case, $l = 100$ ft., $d = 7$ ft.

From another aspect, consider the figure



$A B C D$ being one vertical section of a strut or compression member, of which the center horizontal section is as before a perfect square. The vertical section at right angles to $A B C D$ is a rectangular figure of equal depth, and constant width $C D$. $A B = 100$ ft., $C D = 7$ ft., $H' = 2,000,000$ lbs., $F =$ tension that would be developed by a tie holding the sides C and D together. We may say that the weight H' multiplied

by the side $C D$ is equal to the tension F multiplied by the length L : $2,000,000$ lbs. $\times 7$ ft. $= F \times 100$ ft. $\therefore F = 140,000$ lbs., which indicates the size of the lattice and tie plate to be employed at the center. It would appear, therefore, that the middle is one-half the strength of the end tie plate, and that the intermediate, if any, can be proportioned by scaling ordinates to a straight line at the points of their occurrence.

"ENGINEERING-CONTRACTOR"

A Method of Checking Levels.

Sirs—I note in your issue of Sept. 2, 1908, that Mr. J. S. McBride says in discussing level notes: "The only check on levels possible is to run check levels."

The writer wishes to call attention to the following system which is a check not only on the accuracy of the work but on the calculations:

Sta.	LEFT HAND.					RIGHT HAND.			
	B. S.	H. I.	F. S.	Elev.		B. S.	H. I.	F. S.	Elev.
B. M.	4.16	104.16		100.00		7.84	104.16		112.00
T. P.	5.38	102.21	7.33	96.83		6.62	102.21	4.67	108.83
T. P.	2.11	95.35	8.97	93.24		9.89	95.34	3.02	105.23

The notes on the left hand page are kept as ordinary level notes, while the notes on the right hand page are from the reading of the rod held inverted so that the reading is from a point the length of the rod (12 ft.) above the B. M. or T. P. If the rod is not exactly 12 ft. long, say for instance it is 12.005, then the sum of the readings of the rod held in both positions would not always be 12 ft. and there would be a slight variation in the two sets of notes. This method does not of course

give a check on the errors caused by the instrument being out of adjustment but eliminates errors of observation and mistakes in calculation and reading of the rod.

Yours truly,

N. F. HOPKINS

Pittsburgh, Pa., Sept. 8, 1908

Reinforced Concrete Block Sewer Construction.

Sirs. On page 117 of the issue of ENGINEERING CONTRACTING for Sept. 2nd you illustrate and describe the Parmley reinforced concrete block construction for sewers and state that you are not informed whether or not the construction has been actually used in sewers.

In this connection I wish to state that the construction has been both extensively and successfully used in many cities during the past four seasons. Among a few

of these cities may be mentioned Cleveland, Sandusky and Toledo, Ohio, Adrian, Flint and Grand Rapids, Mich., St. Joseph, Mo., Atchison, Kan., Reading and Altoona, Pa., Newark, N. J., Holyoke and Everett, Mass., Bath, Maine, etc. The city of St. Paul is using about 4,000 lin. ft. of 54 in. diameter on main gravity water supply and Toledo is just finishing up \$97,000 of these sewers ranging in size from 72 ins. to 24 ins. in diameter. All circular and standard English egg-shaped sewers are used. The same



Portable Concrete Mixing Plant on Street Work.

method is applied to manholes, and the city of Reading, Pa., has something like one mile of this kind of manhole construction.

Yours truly,

W. C. PARMLEY.

New York, Sept. 12, 1908.

The Disuse of C. E. by Civil Engineers.

Sirs: The article in the Sept. 2 issue of *ENGINEERING CONTRACTING*, under the heading "The disuse of C. E. By Civil Engineers" is quite worthy of consideration by the members of the profession; and many of the ideas therein advanced contain food for thought and practice.

However, I do not quite agree with the assertion that in this day "the general standing of the profession is raised in the eyes of the community by the use of legalized titles and degrees." I believe that just as much respect, and possibly more, may be received at the hands of the community by the use of the title "Civil Engineer," as by the use of the suffix "C. E."

That some measure should be devised effectually to prevent the abuse of the use of the designation of the profession I most fully agree; but I fail to see wherein the acceptance of any of the measures proposed from time to time will accomplish the desired result. To raise the standard of thought and realization of the importance and the responsibility imposed and the assumption of the duties in the practice of the profession would seem, as suggested in your article, a better means of accomplishing the result desired.

Just as long as mankind will continue to gamble in illegal financial ventures, just so long will the respective sections of our land continue to employ fake engineers.

Yours truly,

BYRNES BRUNE.

Seattle, Wash., Sept. 9, 1908.

A Concrete Mixing Plant for Laying Pavement Foundation.

The engraving on page 183 shows a portable concrete mixing plant being used by The Standard Paving Co., Chicago, Ill., for constructing 6-in. concrete foundation for pavement. The plant consists of a Koehring mixer with charging bucket and mounted on wheels so as to be self-propelling. In the work shown this plant with a gang of 26 men laid 1,170 sq. yds. of foundation in 9 hours. This gives a rate of 130 sq. yds. of foundation or 212-3 cu. yds. of concrete in place per hour. Assuming wages to be \$2 per day, the labor cost of the concrete in place was about 4½ cts. per square yard or 27 cts. per cubic yard.

For the work shown the mixer was equipped with an elevating charging hopper, whose edge is only 12 ins. above the ground so that no inclines or platform was needed for charging the mixer with burrows. We are indebted for the above information to the Koehring Machine Co., Milwaukee, Wis.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *ENGINEERING-CONTRACTING*. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 9872. **Dump Buckets and Dump Cars.**—(L. L. Stuebner Iron Works, Long Island City, New York.

This 155-page cloth-bound book might be called a handbook on hoisting and dump buckets, narrow gauge dump cars, and wheelbarrows and charging barrows. Various styles of buckets, cars, tracks and barrows are illustrated and described and the sizes and capacities with the prices are given in tabular form. Other products made by this company are also shown. A useful catalog.

No. 9873. **Cableways.**—New York Cableway and Engineering Co., 2 Rector St., New York.

A small folder showing the design and operation of the cableway manufactured by this company. Also the hoisting engine used in operating the cableway. Cableways of this design have been built with a 2,500-ft. spans, carrying loads up to 20 tons.

No. 9874. **Reinforcing Steel.**—Universal Unit System, 132 Nassau St., New York.

A 16-page pamphlet showing the rods, connections, separators, spacers and attachments for reinforcing steel for concrete construction and other purposes. Advantages and uses for the system are pointed out, and examples of work done are illustrated.

No. 9875. **General Supplies.**—Fairbanks Co., 116-120 Broome St., New York.

A 1,400-page cloth bound catalog of the various supplies and tools manufactured by this well known company. These consist of scales and measures, valves and pipe fittings, boiler and engine fittings, oil filters, trucks, packing, stocks and dies, wrenches, drills, forges and blowers, blacksmith's and machinist's tools, hammers for all purposes, bolts, screws and rivets, shaft hangers and pulleys, link belting, belt appliances, nails, track tools, jacks, hand cars and small cars, barrows, road machinery and excavating tools, hoisting machinery, blocks, chain hoists, dump buckets, picks and shovels, wood working tools and many other supplies. The book has a good index.

No. 9876. **Victor Dump Wagons.**—F. H. Hieber & Co., Pittsburg, Pa.

The dump wagon described and illustrated in this 16-page pamphlet is worth studying for its novel and simple bottom door operating mechanism. This device as well as the other parts of the wagon are described in detail, sizes and capacities of wagons are given, and commendatory letters from users are printed.

No. 9877. **Progress in Sewage Treatment.**—Merritt & Co., Philadelphia, Pa.

In a 28-page pamphlet with the above title the company named has printed a well presented abstract of Mr. Geo. W. Fuller's "Comparative Resume of the Sewage Purification Tests at Columbus, Ohio," with extracts from the discussion of the paper. The pamphlet also presents a bibliography of recent articles on sewage treatment, with descriptions of Aerlock sewage ejectors, lifts, siphons and sluiceways. The pamphlet is worth securing.

No. 9878. **Raymond Concrete Piling.**—Raymond Concrete Pile Co., Chicago, Ill.

This handsomely printed 22-page pamphlet presents a number of arguments in proof of meritorious features claimed for the concrete pile construction controlled by the above named firm. Among the features considered are: The influence of the shell upon the permanence; the advantages of the tapering shape; success of economy; speed of placing; reinforcing methods; carrying capacity, and cost. The method of constructing Raymond piles is described and tables of sizes are given.

No. 9879. **Revolving Steam Shovels.**—Browning Manufacturing Co., Mansfield, O.

The shovel described and illustrated at work in this 16-page pamphlet is mounted so as to revolve around a full circle. It is adapted for excavating cellars, in brick yards and other places where space is contracted. These shovels are made for both steam and electric operation.

Personals.

Mr. Francis W. Collins, of New York City, is engaged in valuing an electric railway in Ohio.

Mr. Arthur H. Ebeling has opened an office in the Marquette Bldg., 116 West Third St., Davenport, Ia., and will engage in the practice of Architecture.

Mr. F. H. Newell, Director U. S. Reclamation Service, sailed Sept. 15 for Honolulu, Hawaii, to investigate the water supply and irrigation possibilities of the islands.

Mr. John C. Sesser, formerly Engineer of Maintenance of Way of the Chicago, Burlington & Quincy R. R., has been appointed Contracting Engineer of the Walsh Construction Co., General Contractors, Davenport, Ia.

D. C. and Wm. Jackson, Consulting Engineers, have removed their western office from Madison, Wis., to the Commercial National Bank Bldg., Chicago, Ill. Mr. William J. Crumpton will be in immediate charge of the office.

Charles K. Lord, President of the Tonopah & Goldfield R. R., and formerly Third Vice President of the Baltimore & Ohio R. R., died last week in the Presbyterian Hospital, Philadelphia, Pa., of Bright's disease. Mr. Lord was one of the four commissioners who supervised the rebuilding of the burned district after the great fire in Baltimore in 1903. He was 60 years of age.

John B. Brown, prominent during the last 30 years in the development of the transportation resources of Chicago, Ill., died Sept. 10 at his summer home at Ipswich, Mass. Mr. Brown came to Chicago in the '70s and soon became largely interested in railroad construction. He was largely interested in the building of the Chicago & Western Indiana R. R. into Chicago and was the first president of the road.

The following transfers have been made in the U. S. Reclamation Service: Mr. J. C. Cleghorn, Assistant Engineer, from Minidoka Project to Yakima Project. Mr. A. G. Anderson, Junior Engineer, from Minidoka Project to Flathead Project. Mr. E. E. Teeter, Junior Engineer, from Minidoka Project to Okanogan Project. Mr. O. H. Schmidt, Junior Engineer, from Minidoka Project to Sunnyside Project. Mr. J. S. Moore, Junior Engineer, from Minidoka Project to Sunnyside Project.

Mr. John T. Whistler, M. Am. Soc. C. E., has resigned from the U. S. Reclamation Service after six years service, and has opened an office in the Chamber of Commerce Bldg., Portland, Ore., where he will engage in a civil and hydraulic engineering practice. Previous to his connection with the reclamation service Mr. Whistler was employed professionally in railroad work, irrigation development, hydraulic mining and similar lines of work, in the United States and in Central and South America.

Elbridge H. Becker, Civil Engineer in charge of construction of the Pacific extension of the Chicago, Milwaukee & St. Paul Ry., died Aug. 27 at Missoula, Mont., aged 54 years. Mr. Becker began railroad work in 1879 as transitman in a party locating the Fergus Falls branch of the St. Paul, Minneapolis & Manitoba R. R. From 1880 to 1884 he was consecutively Assistant Engineer on location and Resident Engineer on Construction on the Yellowstone and Rocky Mountain Divisions of the Northern Pacific Ry. From 1884 to 1885 he was Division Engineer of the Canadian Pacific Ry., and for a short time was Resident Engineer of the Northern Pacific Ry. From 1886 until 1891 he was Resident Engineer, Assistant Chief Engineer and Chief Engineer of the Montana Central R. R., and from the latter year until 1893 was Chief Engineer of the Montana Central and the Pacific Coast extension of the St. Paul, Minneapolis & Manitoba Ry. In 1894 he was Chief Engineer in charge of construction of the United Verde & Pacific in Arizona, after which he became a Consulting Engineer in Chicago. Later he became associated with the Winston Brothers Co., Minneapolis, and has been with that company ever since. In 1897 he had charge of the double-tracking of the Madison division of the Chicago & Northwestern Ry., and in 1899 had charge of the extension of the Chicago & Northwestern from Burt, Ia., to Sanborn, Minn. In 1901 he was connected with the construction work of the Verdigris extension of the Chicago & Northwestern in Nebraska and South Dakota, and in 1905 was engaged in some heavy construction work in Louisiana. In 1906 and 1907 he worked on some extensive irrigation projects in the vicinity of Calgary, Alb., since which time he had been in charge of the most difficult construction of the Pacific Coast extension of the St. Paul, building that part through the Bitter Root Mountains in Montana.

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**Announcement of Proposed Increase
of 240 Reading Pages for the Year
in Engineering-Contracting.**

On the first of January, 1908, a decided increase in the size of ENGINEERING-CONTRACTING was effected by the addition of our Monthly Review Index of Civil Engineering Literature. The time is now ripe for another addition, which will be in the form of six more reading pages each week, excepting the first issue of the month, which has always been a large issue, aside from the reviews of engineering articles contained in the Index.

Many of our readers will recall that two years ago this journal was able to furnish but six reading pages a week, or only as much, all told, as we now intend to add at one stroke. We announced at that time that our purpose would be to give quality rather than bulk, but that we should eventually add to the bulk of the paper while still maintaining its reputation for excellence in quality of articles published. From time to time we have made additions, as fast as the growing income of the paper would warrant, and it is our hope that we shall be able to make another substantial increase in the size of the paper early in the year of 1909.

Beginning in October our readers will receive these six additional pages of reading matter, which, in the course of the year, will aggregate 240 pages more than in any previous year. The subscription price will remain \$2.

While it may be somewhat early in the season to think of "Christmas shopping," we ask our readers to bear in mind that no present is likely to be more acceptable to any engineer or contractor than an annual subscription for ENGINEERING-CONTRACTING.

Day Labor Versus Contract Work.

We notice in a report from Bridgeport, Conn., that the mayor of the city is quoted as saying that he is much pleased with the paving of Cannon street by the city's own forces. He is reported as saying that, while the work may cost a little more than a contractor would charge, he believes the quality of the work is better and he believes that the pavement, which is brick, will last longer without losing its shape.

These remarks again bring up a comparison of contract work and that done by day labor. The mayor of Bridgeport is frank enough to acknowledge that the work done by day labor is costing more than if done by a contractor. It is only in exceptional cases where this is not so. It is human nature to be extravagant when one is not spending one's own money, and this is generally the case with day labor work. On the other hand, a contractor, knowing that all extra cost is coming from his own pocket, sees to it that many preventable wastes are eliminated. This fact accounts for the great amount of construc-

tion work that is sub-contracted. The contractor knows his "sub" will do the work cheaper than the ordinary foreman, especially if the contractor cannot give the foreman personal supervision.

From time to time this journal has pointed out examples of day labor work costing much more than it would have cost if done by contract. This has been true of a vast amount of construction done by the national government, such as dredging harbors and channels, structures for the Reclamation Service, locks and dams and much work done in and around our fortifications. The city of Boston has just realized that a million dollars has been wasted by crushing the rock used by the city, instead of buying it by contract. The city of Los Angeles is beginning the building of an aqueduct more than 300 miles long, doing most of the work, to date, by day labor. From reports that come to us the work now seems to be handled well and is being done economically, but the undertaking is a large one, running in cost to many millions of dollars, and before it is finished there is no telling what the cost may be. A word of warning at the beginning may save the city much money.

There is another feature of day labor work touched on by the mayor of Bridgeport—namely: the quality of the work. Before the paving is finished, he says, it is of a better quality. If the work proves so in this case it will be an exception rather than the rule, for with day labor, specifications are seldom lived up to as is done under contract work. Several years ago the writer was connected with some paving done by day labor, and 90 days after it was finished some repairs had to be made to the paving owing to poor workmanship. This was a cost that was not figured in with the cost of the original work. With contract work under such conditions the contractor would have had to "make good," as either his retained percentage would be held up or his guarantee bond would compel him to repair the work.

With contract work an inspector is kept on the job, but with day labor work the inspector's salary is saved. It would be money well spent to have him on the job under the day labor system. Generally speaking, one of the results of doing work with day labor is an inferior quality of work as compared to that done by the contract system.

The Chilean government has advertised for bids for the construction of the Arica-La Paz Railway, a line of about 335 miles, and also the connecting links in the north and south line known as the "Longitudinal Railway," with changes of the gage of some of the connecting lines. This latter group covers about 300 miles and starts from a point a short distance north of Valparaiso. Plans, specifications and estimates for these undertakings are on file at the Chilean Legation, Washington, D. C.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

A Discussion on Metal Forms for Concrete.*

Mr. E. S. Larned: In one piece of construction coming under my supervision we used galvanized iron centers with the idea, of course, that it would give a smooth, hard surface; it did, but still it was imperfect in places, due to nail heads, creases in the iron, and other causes, and we were obliged to put a skin coat of Portland cement on this surface. The centers had been oiled, which added to the difficulty. In order to accomplish this work, we were obliged to wash the concrete surface with a strong alkali solution in order to remove the oil, and even then it was almost impossible to avoid peeling and defective work in this skin coat.

In the use of metal forms I would suggest the thought that we introduce an element in concrete work which perhaps, from an artistic standpoint, is not particularly desirable, and from a practical point of view, if your metal forms are subject to deformation, indentations, etc., they are going to be more or less injured by use. As has been remarked, if the forms are to be handled by butchers, they will in a short time be in pretty bad shape, and while the metal forms are not destroyed, as in the case of lumber, they will give you irregular corners and imperfect surfaces.

While it is desirable to use as light metal forms as possible by reason of the work required in removing them, still it is obvious that light metal forms will require more frequent supports and will be more subject to deformation and injury.

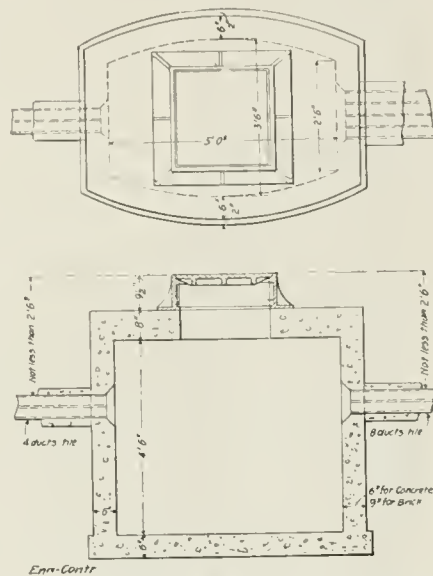
Mr. Goodrich: Another point against metal forms is that drops of water form on the centers and leave little pockets in the concrete. When this is the case it is almost impossible to retain a plaster finish.

Mr. P. P. Comoli: The difficulty in the use of metal forms is that they must be greased thoroughly, otherwise the cement will stick and you will have difficulty in removing them. The longer the form is on the greater will be the difficulty. You cannot always remove the forms as quickly as you wish, especially if, for instance, a spell of rainy weather occurs, where it might be eight or ten days before you can take the forms down. The disadvantage of greasing the form is that it will either effect the concrete so that the surface will peel off or it will produce an unsightly discoloration.

*Extracts from discussion at the annual convention of the National Cement Users' Association

Cost of Constructing Four Concrete Vaults for Underground Conduit.

In our issue of Aug. 12, 1908, we give the itemized cost of constructing 218 concrete vaults for underground conduit. In the accompanying table we give the cost of constructing four vaults of the dimen-



Plan and Section of Vault.

sions and form shown by the accompanying drawing. This table is of interest as showing work done under a single set of conditions, the sand, soil, etc., remaining unchanged. It also gives separately the items of car fare and board. The wages, and methods of construction, etc., were the same as given for the work described

TABLE SHOWING ITEMIZED COST OF CONSTRUCTING FOUR CONCRETE VAULTS FOR UNDERGROUND CONDUIT.

	Cost of teaming.	Cost of excavating.	Cost of placing floor.	Cost of placing sides.	Cost of placing top.	Super-vision.	Board.	Car fare.	Total cost.
	\$4.08	\$4.34	\$1.17	\$6.11	\$3.07	\$2.00	\$0.50	\$0.22	\$21.52
	3.77	4.15	1.14	5.38	3.41	2.43	0.62	0.08	21.28
	3.86	5.62	1.12	5.94	3.26	2.36	0.58	0.11	22.85
	4.12	6.04	1.25	5.47	3.11	2.14	0.54	0.10	22.77
Total	\$15.83	\$20.45	\$4.68	\$22.93	\$12.85	\$8.93	\$2.24	\$0.51	\$88.42
Average	\$3.96	\$5.11	\$1.17	\$5.73	\$3.21	\$2.23	\$0.56	\$0.13	\$22.10

in our issue of Aug. 12. These figures have been furnished us by Mr. Clarence Mayer, Chicago, Ill.

A new aeroplane record was made on Sept. 21 by Wilbur Wright at Le Mans, France, where he accomplished a flight of 1 hour, 31 minutes and 51 seconds, covering 61 miles.

Tests of the Effect of the Addition of Clay and Alum Solution on the Tensile Strength and Impermeability of Mortar.

BY M. H. M'GEE.*

Experimental tests have been conducted by the Ulster and Delaware Railroad Co. to determine the impermeability of concrete by the addition of so called "col-

TABLE 1—SHOWING TENSILE STRENGTH OF MORTAR WITHOUT ADDITIONS OF CLAY OR ALUM.

Brickette number.	Parts cement.	Parts sand.	Per cent alum.	Lbs. per sq. in.		
				7 days.	28 days.	90 days.
1	1	33	226	392	370	
2	1	33	225	352	376	
3	1	33	225	408	372	
4	1	33	216	334	418	
5	1	33	216	446	412	
6	1	33	212	440	392	
7	1	33	221	362	380	
8	1	33	216	374	422	
Average			222	388	392	
1	1	33	225	404	342	
2	1	33	216	410	401	
3	1	33	211	412	406	
4	1	33	264	394	264	
5	1	33	224	410	422	
6	1	33	36	368	490	
7	1	33	223	398	488	
8	1	33	233	402	378	
Average			236	399	412	
1	1	33	253	330	378	
2	1	33	230	269	360	
3	1	33	248	318	330	
4	1	33	230	310	340	
5	1	33	250	314	342	
6	1	33	286	342	358	
7	1	33	249	330	406	
8	1	33	273	312	355	
Average			251	328	358	

loids" or clay, and also to determine if increased strength were to be obtained by such an addition, and following the same line of experimentation as conducted by the Board of Water Supply of New York City (Eng. Contr., Feb. 26, 1908), the tabulated results given herewith were obtained.

The tests were made by using clays of three different kinds, as found at various points along the line of the Ulster and

Delaware railroad.

Clay No. 1, or "Red Bridge," consists of a hard, tough dark red clay, very heavy in weight and which when dry is somewhat hard to pulverize.

Clay No. 2, or "Shanaken," is a red clay, light in weight, rather easily pulverized when dry.

*Engineer of Bridges, Buildings and New Construction Ulster & Delaware R. R., Kingston, N. Y.

Clay No. 3, or "Olive Branch," is gray in color, very heavy in weight and easily pulverized.

After the clay was finely pulverized and screened to pass through a 2,500 meshes to the square inch sieve, each was mixed dry with Atlas Portland cement in the propor-

tion of 1-7 and 2-7, making each resultant compound respectively a 12½ per cent and 22 per cent mixture. The cement and clay were then thoroughly mixed together dry in a revolving cubical box to insure their thorough incorporation. Coarse, sharp sand in proportions of three parts

sand to one cement and clay composition was used for making test briquettes.

The entire series of tests were conducted under the auspices of the Consolidated Rosendale Cement Company's testing laboratory and under direction of their expert tester. Tables I and II show the results of the tensile strength tests.

The tests for impermeability were made as follows: For each test a piece of 3-in. wrought iron pipe about 1 ft. long, threaded at one end to connect direct with the city water pressure (which registers 110 lbs. per sq. in.) and arranged with a pres-

TABLE II—SHOWING EFFECT ON TENSILE STRENGTH OF MORTAR OF ADDITIONS OF COLLOIDS OR CLAY AND OF ALUM.

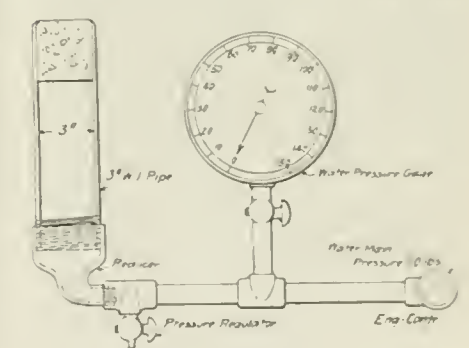
Cement and clay mixture—parts.	Coarse, sharp sand—parts.	Alum solution—per cent.	Tensile strength—lbs. per sq. inch.			Cement and clay mixture—parts.	Coarse, sharp sand—parts.	Alum solution—per cent.	Tensile strength—lbs. per sq. inch.		
			7 days.	28 days.	90 days.				7 days.	28 days.	90 days.
Red Bridge, clay 1 part, cement 7 parts.						Red Bridge, clay 2 parts, cement 7 parts.					
1	3		263	326	360	1	3		191	229	346
1	3		248	332	402	1	3		186	217	323
1	3		254	344	498	1	3		210	225	321
1	3		263	318	429	1	3		181	228	320
1	3		257	312	428	1	3		173	221	328
1	3		263	304	426	1	3		185	223	356
1	3		296	326	400	1	3		199	216	319
1	3		236	322	416	1	3		190	221	340
1	3		249	309	423						
1	3		274	318	404						
Average			260	332	417	Average			189	222	331
1	3	5	191	240	370						
1	3	5	182	237	389	1	3	5	140	271	290
1	3	5	201	287	351	1	3	5	132	241	340
1	3	5	197	252	394	1	3	5	154	242	326
1	3	5	202	222	317	1	3	5	142	253	310
1	3	5	189	279	358	1	3	5	144	249	320
1	3	5	180	288	362	1	3	5	149	262	342
1	3	5	179	236	373	1	3	5	147	249	334
1	3	5	178	234	354	1	3	5	138	271	306
1	3	5	178	229	349						
Average			188	250	363	Average			143	254	321
1	3	2½	218	274	330						
1	3	2½	197	273	378	1	3	2½	200	240	352
1	3	2½	190	282	346	1	3	2½	202	245	318
1	3	2½	200	295	356	1	3	2½	189	232	302
1	3	2½	220	266	374	1	3	2½	207	237	359
1	3	2½	195	287	380	1	3	2½	207	249	294
1	3	2½	193	289	420	1	3	2½	212	239	314
1	3	2½	197	250	384	1	3	2½	195	244	305
1	3	2½	204	284	361	1	3	2½	198	226	309
1	3	2½	223	293	352						
Average			203	279	366	Average			201	239	318
Shanoaken, clay 1 part, cement 7 parts.						Shanoaken, clay 2 parts, cement 7 parts.					
1	3		203	273	360	1	3		211	297	410
1	3		200	288	393	1	3		193	314	394
1	3		212	253	396	1	3		203	322	390
1	3		192	286	304	1	3		214	326	358
1	3		199	299	382	1	3		225	374	380
1	3		210	274	392	1	3		176	360	396
1	3		198	288	370	1	3		175	298	394
1	3		194	305	222	1	3		223	334	350
Average			204	285	361	Average			202	328	384
1	3	5	226	248	312	1	3	5	143	210	250
1	3	5	201	259	340	1	3	5	143	238	248
1	3	5	188	273	390	1	3	5	134	210	256
1	3	5	196	248	330	1	3	5	136	242	262
1	3	5	193	255	302	1	3	5	131	220	390
1	3	5	230	275	312	1	3	5	140	199	346
1	3	5	232	275	330	1	3	5	147	203	280
1	3	5	197	251	314	1	3	5	138	217	321
Average			208	258	328	Average			139	217	291
1	3	12½	188	275	400	1	3	12½	188	320	344
1	3	12½	197	335	302	1	3	12½	200	362	370
1	3	12½	208	292	384	1	3	12½	197	280	340
1	3	12½	204	320	314	1	3	12½	175	302	380
1	3	12½	194	344	320	1	3	12½	190	328	356
1	3	12½	181	358	392	1	3	12½	213	303	362
1	3	12½	202	346	351	1	3	12½	192	279	391
1	3	12½	190	303	336	1	3	12½	192	310	404
Average			194	321	349	Average			193	310	365
Olive Br., clay 1 part, cement 7 parts.						Olive Br., clay 2 parts, cement 7 parts.					
1	3		241	334	400	1	3		219	320	352
1	3		225	350	440	1	3		216	300	400
1	3		246	314	413	1	3		207	344	322
1	3		216	322	422	1	3		224	304	352
1	3		222	340	409	1	3		223	328	352
1	3		255	320	442	1	3		209	302	418
1	3		242	369	410	1	3		223	326	394
1	3		221	313	403	1	3		233	334	340
Average			234	332	417	Average			219	321	361
1	3	5	151	276	360	1	3	5	172	241	366
1	3	5	168	332	364	1	3	5	155	251	362
1	3	5	146	280	310	1	3	5	146	244	320
1	3	5	147	274	340	1	3	5	171	257	280
1	3	5	167	299	314	1	3	5	157	270	264
1	3	5	153	304	301	1	3	5	160	264	312
1	3	5	128	276	305	1	3	5	156	298	209
1	3	5	149	282	310	1	3	5	180	293	227
Average			151	290	326	Average			162	254	248
1	3	12½	185	330	395	1	3	12½	220	340	380
1	3	12½	173	346	380	1	3	12½	223	324	391
1	3	12½	185	320	394	1	3	12½	223	372	428
1	3	12½	183	324	362	1	3	12½	228	388	440
1	3	12½	182	361	436	1	3	12½	224	381	342
1	3	12½	186	329	352	1	3	12½	226	370	402
1	3	12½	183	354	339	1	3	12½	261	350	296
1	3	12½	209	352	347	1	3	12½	277	372	446
Average			185	339	375	Average			244	357	288

TABLE III—SHOWING DEGREE OF IMPERMEABILITY OF DIFFERENT MORTAR MIXTURES

Cement and clay mixture—parts.	Sand—parts.	Alum solution—per cent.	Thickness of test piece, ins.	Effect on test pieces of different water pressures applied		
				15 lbs.	25 lbs.	40 lbs.
1	3	0	3	Moist.	Sweating.	Dripping.
1	3	0	6	Dry.	Dry.	Moist.
1	3	0	5	Dry.	Dry.	Dry.
1	3	2½	3	Moist.	Sweating.	Dripping.
1	3	5	3	Moist.	Sweating.	Dripping.
1	3	2	6	Dry.	Dry.	Dry.

sure gage to measure the direct head or pressure desired to impart thereto for impermeability test. The pieces of pipe were then stood on end on a table and filled with cement mortar in depths ranging from 3 ins. to 8 ins. in thickness tamped. The cement for these tests contained pulverized clay in proportion of 1-7. The mortar was mixed 1-3 proportion and allowed to set 2 hours in air and 6 days in water before testing under pressure. (See Table III.)

From the results obtained by these tests



Apparatus for Impermeability Tests.

it would appear that a concrete wall, properly constructed and to have a facing mortar of not less than 8 ins., containing the colloids, or clay, on the side of the wall or structure next in contact with the water, ought to be perfectly waterproof and practically dry for a head of water up to 100 ft. in height; and a mixture of clay with cement in the proportions of 1-7 tends also to increase the tensile strength of concrete, while the proportion of 2-7 contains too much clay and weakens the resultant mixture, and that the tests containing alum solution gave poorer results for tensile strength than those without it.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Tunnel Driving at Low Cost.*

BY WALTER H. BUNCE.

The driving of the Chipeta adit at Ouray, Colorado, was not especially notable as an important operation, but on account of the rapid driving and the resultant low costs, attention was attracted to it. The adit was projected as a working entry to simplify the mining of the American-Nettie quartzite stratum, which had faulted downward. The old entries were tortuous inclines terminating at the fault. The portal is in the face of the steep mountain forming one wall of the canyon north of the town of Ouray, at an altitude of nearly 9,000 ft. and 1,700 ft. above the bed of the river. For economic reasons the power plant was placed at the river and a line of 3½ in. standard pipe was laid on the surface to carry compressed air to the adit. This pipe line, 3,400 ft. long, has given no trouble in summer or winter.

During the installation of the plant and pipe line, work was carried on by hand labor, the adit reaching a length of 263 ft., including the portal section of 115 ft., which was heavily timbered 7 by 7 ft. in the clear. Machine drilling was then started and a run, which lasted for five full months, was made, only two rounds of holes being lost in that period.

This run of five months (152 days) resulted in driving the heading 7½ by 7½ ft. in the clear, a distance of 1,712½ ft. in hard rock; a monthly average of 342½ ft. The best weekly record was 85 ft.; the best month (31 days) was 359 ft. But two 8-hour shifts per day were employed. Compressed air at about 100 lbs. was supplied to a pair of 3½ in. New Ingersoll drills, both mounted on one single-screw column set horizontally above the muckpile. The round, consisting of from 15 to 19 holes, was drilled—except the lifters—from this setting, the bar being reset for the lifters after the muck was away. The cut was taken from the bottom, uniformly. Three drill men tended the two machines, drilling a full round each shift.

An unusual system of "mucking" was employed, which, perhaps more than any other one thing, may account for the substantial rate of progress. The tunnel track, 19-in. gage, was carried close to one side of the adit, and a floor consisting of steel plates and planks was maintained with the greatest care for not less than 60 ft. back from the heading. This floor was moved forward every round. No switches or turnouts were used; cars measuring 20 cu.

ft. capacity were specially designed and these, although weighing empty 1,000 lbs. apiece, were so perfectly balanced that the empty cars composing an incoming train were easily "jumped" off the track on to this floor, the loaded cars passed by, and then the empties replaced on the track in detail as required by the muckers for loading. Muck was handled with No. 6 square-pointed shovels. Four shovelers and a mule driver composed each shift. Track was laid and leveled by the muckers. Each shift, composed of drill men and muckers, started work together. No ventilating system was installed, the smoke being blown back with air from the compressor. The adit throughout its entire length was perfectly dry.

This adit was an independent operation, the employees having no other occupation, so that their total wages are a charge against the work. Their wages were: Foreman, \$5; drill men and blacksmith, \$4; blacksmith helper, \$3.50; muckers, \$3; compressor engineers, \$3.50 per 8-hour shift. No bonuses were paid except on Christmas day, when double time was given. The following costs are computed from March 1, when 1,835 ft. (including the portal section) had been completed, and embrace every item outside of construction and equipment accounts, which were closed before the current accounts were opened. The "Power" account covers labor, coal, oil, and lights, everything at the compressor station; "Labor" covers all other labor except that charged into "Lumber and Timbers." "Tunnel Expense" covers tool renewals and repairs, blacksmith's sundries, forage, oils and general sundries at tunnel; "Track and Pipe" covers cost and transportation of rail, fittings, ties, pipe, and pipe fittings; "Expense" covers city office, rent, furniture and incidental expenses. The compensation of the acting superintendent is nowhere included in the costs as shown.

Distribution of costs.	Total.	Cost per ft.	Cost per cu. yd.
Tunnel expense	\$556.94	\$0.303	\$0.145
Track and pipe	1,532.26	0.835	0.401
Power	2,862.71	1.560	0.750
Lumber and timber	533.51	0.291	0.140
Labor	11,981.85	6.529	3.138
Lights	233.70	0.127	0.061
Explosives	3,522.06	1.919	0.918
Expense	836.11	0.455	0.219

Total 1,835

cu. ft. \$22,039.14 \$12.02 \$5.772

Pipe line through tunnel is 3½-in. standard black pipe. Track is 16-lb. section, on

ties laid 20 in. apart. Powder (10 per cent dynamite) costs \$0.1315 at the portal. Close estimation places its consumption at 14.5 lb. per foot for machine driving. Steam coal cost \$3 per ton at the boilers. The air pressure was nominally 100 lbs. and a recording gage kept on the line proved of value in many ways. There was always plenty of air. No charge for depreciation of tools and equipment has yet been entered; renewals and repairs are made and charged currently to "Tunnel Expense" and the actual value of the outfit to the company is about equivalent to new, as nothing has been allowed to run down.

[The column showing the cost per cu. yd. has been added to the original article. In ENGINEERING-CONTRACTING for Jan. 1, 1908, p. 9, a description of some rapid tunnel driving for mining purposes in the Cripple Creek district of Colorado was given. Some of the methods used at Ouray were similar to those followed at Cripple Creek. It is of interest to note that 7 lbs. of dynamite were used for each cu. yd. of rock excavated.—Editors.]

The Installation of a Quarry Plant at Panama.

Two million cubic yards of crushed rock will be required for concrete in the locks at Gatun and the spillway in Gatun dam, on the Panama canal. There will also be other needs for crushed stone on the canal work and its appurtenances. To supply this rock a quarry is being opened at Porto Bello, a harbor on the Caribbean Sea, 18 miles east of Colon. The rock here is a massive andesite, well suited for concrete, and the deposit of rock is large, as exploration by means of borings, justifies an estimate of 20,000,000 cu. yds. of good rock.

The quarry is located within 25 miles of Gatun, with water transportation. The harbor at Porto Bello is an excellent one. The rock can be sent from the quarry to the crusher, and from the crusher to the conveying system by gravity, which should reduce the cost of handling it.

The quarries are being opened on the hill that arises almost sheer from the water, on the north shore of the bay. At an elevation of 85 ft. a 45-ton steam shovel is digging a terrace around the hill for the double track system to the crusher house. Excavation for the crusher plant, and grading for the railway track into the quarry is in progress. This shovel was lifted from sea level up an incline 120 ft. long, on part of which the grade was 66 per cent. A track was laid up the hill, an anchorage or "dead man" was buried at the top of the incline, and a double cylinder, double drum, hoisting engine of 30 hp., located at the foot of the hill, supplied the power, use being made of an eight part tackle.

At an elevation of 260 ft. above sea level a Decauville is in operation, distributing material along the 3,500 ft. of hillside that it is proposed to strip. Material is sent

*Reprinted from "Mining and Scientific Press."

to the 260 ft. level by a trolley, operated by a hoisting engine at the foot of the hill. Stripping will be done hydraulically, and to this end a 10-in. hydraulic line has been run from elevation 1 to elevation 260, and 3,500 ft. along the terrace at elevation 260. On the steep incline the pipe is anchored in concrete piers about 150 ft. apart. A pump capable of delivering 1,500 gals. of water per minute against a total stack and friction head of 460 ft. has been installed on the shore, with an intake from the bay. Steam for this pump will be furnished by two boilers of 370 hp., now ready for operation.

From the quarry, running from elevation 85 to 260, rock will be delivered at the crusher plant at elevation 85. This plant will consist of two No. 9 and four No. 6 McCully crushers, manufactured by the Power & Mining Machinery Co., of Cudahy, Wis. These six crushers are now on the ground ready for erection. A double transmitting pan conveyor will take the crushed rock from the crusher to a hopper beneath the shipping bin located on the water line. This hopper empties into a double distributing bucket conveyor which elevates the crushed stone and delivers it, by means of trippers, at the points desired in the bin. Foundations have been installed for the stone bin and coal bunkers. The bin will have a capacity of 2,400 cu. yds. and the bunkers of 1,000 tons. The stone will be discharged from the bin into barges by gravity. Twelve barges and three tug boats will be employed in the service between Porto Bello and Cristobal. Each barge will carry 600 cu. yds., and it is expected to deliver 2,400 cu. yds. per day. Delivery is to commence Jan. 1, 1909.

At present the drilling is being done by Star drills, but as soon as one air compressor is installed, pneumatic drills will be used. A permanent 6-in. air line has been laid at elevation 260 to supply air to all parts of the quarry. A 2-in. water pipe is also being laid at elevation 288. Tanks with capacity of 10,000 gals. will be erected at this elevation and kept filled by pumping from the water main. From these tanks the quarters above the reservoir level will be supplied by gravity, as will steam shovels and drills in the quarry, from a line laid at elevation 260. A reservoir has been built on an adjoining hill.

Between the hill in which the quarry is being opened and the hill that forms one side of the reservoir, is a shelf of land 2,000 ft. long and only a few feet above the water. On this strip of land are located the docks, the boiler and engine house, shipping bins, coal bunkers, a machine shop, storehouse and other buildings that form the quarry plant. The quarters of most of the men are also located on this piece of land. Operations on developing this quarry were started in 1907.

We are indebted to the Canal Record for the above information.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Detailed Cost of Constructing Two Small Sewers and Two Manholes at Oskaloosa, Ia.

The following cost data relate to the construction of a 12-in. sanitary sewer in 6th Ave., and an 8-in. sanitary sewer in South Market street, Oskaloosa, Ia.

The 6th avenue sewer consisted of 1,001 lin. ft. of 12-in. tile, five manholes and one lamphole. The work required the excavation of 1,063.8 cu. yds. of material, the average depth being 11.4 ft. and the maximum depth 16 ft. On this sewer there was about 250 ft. of trench in which the depth was from 13 to 15 ft. This necessitated handling part of the dirt three times before it was removed from the trench, which added considerable to the cost of excavation. The cost of the 1,001 lin. ft. of 12-in. sewer was as follows:

Labor.	Total.	Per lin. ft. Sewer.
Trenching	\$543.90	\$0.541
Sheeting	72.00	.072
Laying tile	46.38	.046
Back filling	93.65	.093
Miscellaneous expense, laying pavement, hauling, etc.	45.00	.045
Total, labor	\$800.93	\$0.797
Materials:		
Lumber for sheeting....	\$32.30	\$0.032
Cement for joints, 15 sacks	5.40	.005
Sand for joints, 30 bu....	1.80	.002
Jute calking, 50 lbs.....	3.50	.003
Tile, 958 lin. ft.....	249.08	.248
Specials, 14 at \$0.72.....	10.08	.010
Total, materials.....	\$302.16	\$0.301
One lamp hole, 13 ft. deep	4.20	.004
Five manholes	271.82	.271
Grand total.....	\$1,382.11	\$1.377

In the above work there was 980 lin. ft. of trenching, the cost per lin. ft. being \$0.555. The cost of sheeting the 980 lin. ft. of trench was:

	Total.	Per lin. ft. Trench.
Labor	\$72.00	\$0.073
Lumber	32.30	.033
Total	\$104.30	\$0.106

There were 400 joints requiring 15 sacks of cement and 30 bushels of sand, the cost per joint being \$0.018. The calking for the 400 joints took 50 lbs. of jute, or .125 lb. per joint, and cost \$0.009 per joint.

The South Market street sewer consisted of 816.8 lin. ft. of 8-in. tile, two manholes and one lamphole. There were 365.9 cu. yds. of excavation, the average depth being 6.6

ft., and the maximum depth 10.6 ft. The cost of this sewer was as follows:

	Total.	Per lin. ft. Sewer.
Trenching	\$113.40	\$0.139
Sheeting trench and miscellaneous	15.00	.018
Laying tile	21.25	.026
Back filling	15.25	.019
Cement for joints, 6 sacks	2.16	.002
Sand for joints, 20 bu....	1.20	.001
Tile, 780 lin. ft.....	121.60	.149
Specials, 18 at \$0.72.....	12.96	.016
Total	\$302.90	\$0.369
One lamp hole, 10 ft. deep	4.30	.005
Two manholes	61.89	.081

Grand total

There was 805.6 lin. ft. of trenching, the cost per lin. ft. being \$0.14. There were 327 joints requiring six sacks of cement and 20 bushels of sand, the cost per joint being \$0.011.

In the above work the price for laying tile includes taking out the last spading from the bottom of the trench, and tamping same about tile previously laid. Each tile was laid to line and grade from grade cord supported over trench, the supports consisting of two upright 2 x 4 pieces, and cross board, spaced 25 ft. apart. Joints were calked and cemented, bevel pattern, with 1:1 portland cement mortar.

The backfilling was done with team and scraper and two men. Dirt was first put in trench to within about 1 ft. of the top, and the trench then flooded with the fire hose. The balance of the dirt was then scraped onto the trench. This has proven a very satisfactory method, as practically all of the dirt goes back into the trench in a short time.

The soil consists of from 1 to 3 ft. of black loam on the surface, under which is tough clay. As the ground this summer contained very little water, only skeleton bracing was used.

The prices of materials delivered on the work were as follows:

Cast iron manhole and lamphole covers, \$0.025 per lb.

Wrought iron manhole steps, \$0.24 each.

No. 1 vitrified paving brick, \$11.00 per M.

Cement, \$0.36 per sack.

Sand, \$0.06 per bu., 100 lbs. per bu.

Jute calking, \$0.07 per lb.

8-in. tile, \$0.156 per lin. ft.

10-in. tile, \$0.26 per lin. ft.

Oak lumber, \$38.50 per M.

The wages paid were as follows:

Brick masons, \$0.55 per hour for 8 hours

Tile layer, \$2.50 per day.

Common labor, \$0.20 per hour for 9 hours.

Team and driver for backfilling, \$0.40 per hour

The manholes were built of No. 1 vitrified paving brick on a foundation of 1:1:8 concrete from 8 in. to 1 ft. thick under the walls. Portland cement mortar mixed 1:2 was used in building walls, all joints being slushed full. The walls were 13 in. thick at depths greater than about 12 ft. and 9 in. thick above this depth.

Below is given cost of two manholes of different depths.

Manhole 16.5 ft. deep, requiring 20.4 cu. yds. excavation.

Excavation:

Labor at \$0.20 per hour.....\$ 9.10

Foundation:

Labor at \$0.20 per hour..... 2.10

3 sacks cement at \$0.36 per sack... 1.08

.4 cu. yd. sand at \$1.40 per yd..... 0.56

1 cu. yd. crushed brick at \$2.30 per

cu. yd. 2.30

Superstructure Manhole:

2,100 brick at \$11.00 per M..... 26.40

16 sacks cement at \$0.36 per sack... 5.76

26 bu. sand at \$0.06 per bu..... 1.56

1 C. I. cover, 307 lbs. at \$0.025 per

lb. 7.68

1 dust pan, 50 lbs. at \$0.025 per lb. 1.25

8 steps at \$0.24 each..... 1.92

2 pieces split tile in bottom..... 0.67

Brick mason, 10 hrs. at \$0.55 per hr. 5.50

110d carriers at \$0.20 per hr..... 6.00

Total cost of manhole.....\$72.16

Manhole 8.4 ft. deep, requiring 8.2 cu. yds. excavation.

Excavation:

1 man 13 hrs. at \$0.20 per hr.....\$ 2.60

Foundation:

Labor at \$0.20 per hr..... 0.80

2 sacks cement at \$0.36 per sack... 0.72

.25 cu. yd. sand at \$1.40 per cu. yd. 0.35

.5 cu. yd. crushed brick at \$2.30 per

cu. yd. 1.15

Superstructure Manhole:

1,100 brick at \$11.00 per M..... 12.10

6 sacks cement at \$0.36 per sack... 2.16

10 bu. sand at \$0.06 per bu..... 0.60

1 C. I. cover, 307 ft. at \$0.025 per lb. 7.68

1 dust pan, 50 lbs. at \$0.025 per lb. 1.25

3 steps at \$0.24 each..... 0.72

2 pieces split tile in bottom..... 0.10

Brick mason, 8 hrs. at \$0.55 per hr. 4.40

110d carriers at \$0.20 per hr..... 1.60

Total cost of manhole.....\$36.53

All of the above work was done this summer by day labor under the supervision of Mr. F. F. Bridges, City Engineer, to whom we are indebted for the information from which this article was prepared.

The Turkish government has engaged the English engineer, Sir William Willecocks, to superintend the irrigation works in Mesopotamia and other parts of the Turkish empire. It is believed that with the expenditure of \$40,000,000 on the Tigris Canals 1,250,000 acres could be irrigated.

Methods of Making Repairs to a 72-In. Steel Main Under 30-Ft. of Water.*

BY A. W. CUMBECK,†

The pipe to which these repairs were made is a part of the plant of the Jersey City Water Supply Co. furnishing Jersey City, N. J., with water. This line is about 21 miles long, and runs from a large storage reservoir at Boonton, N. J., across country to Jersey City, and consists of concrete conduits, tunnel and steel pipe. The portion of this line in question under the Hackensack River was laid in 1902, and consists of 11/16 in. riveted steel pipe, 6 ft. in diameter.

The method employed in laying the pipe was as follows: The pipe was furnished on the ground in about 28-ft. lengths, made up of four sheets. These were connected upon the west bank of the Hackensack River on staging suitable for the purpose, carried out across the river and supported on floats. As the pipe was connected, it was enclosed in reinforced concrete rings,

and make an examination. After considerable trouble the contractor who laid the pipe, and who was making the repairs, succeeded in getting the water out on about Jan. 10, 1903. It was then discovered that the pipe had opened up. In other words, a plate had parted about seven-eighths of the way around the pipe, the widest opening, 2 1/2 ins., being on the bottom. It was repaired by putting a complete ring of steel plate inside the pipe over the break and fastening with stud bolts. The ring was put on in five pieces and the repairs finally completed about Feb. 16, 1903, two months after the break was first discovered.

No further trouble was experienced with this pipe until some time in 1904, when an examination of the river crossing developed the fact that there was a small leak. This was discovered by the sound which was plainly audible when passing over the pipe in the river in a boat. In November, 1904, a diver was employed to make an external examination of the pipe, but he could discover no leak, except the noise. Shortly afterwards it was observed that considera-

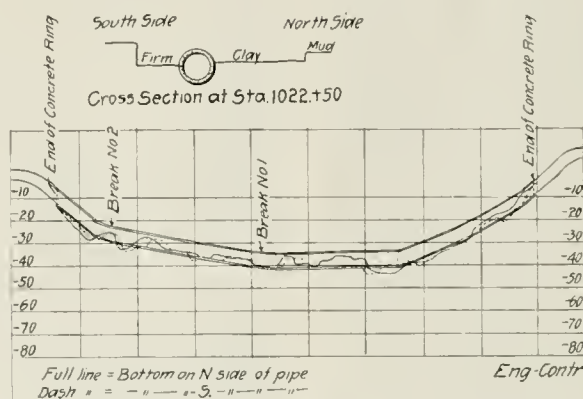


Fig. 1—Profile of Pine Line and Cross Section of Pipe and Trench.

which were made in forms and slipped over the pipe and afterwards grouted, making eventually a continuous concrete covering. The weight of the pipe and concrete covering was just sufficient to sink it. After the pipe composing the river crossing was completed and entirely supported by barges, it was lowered to its final position in a trench that had been prepared for it by dredging, as shown by Fig. 1.

At the time the pipe was lowered into place and just as it was filled with water a break occurred in a field joint at approximately the center of the river. The exact point of this break is noted on Fig. 1. This break was first noticed Dec. 15, 1902, shortly after the pipe was lowered into place and filled with water, and before the ends of the pipe were connected to the balance of the line. After discussing the possible character of the break and the method to be employed in repairing it, it was decided to build bulkheads in each end of the pipe, force the water out by air pressure, go in

ble water was being lost between Boonton and Jersey City. The measurement of the water flowing into the pipe was made through sluice gates at the intake at Boonton, and at Jersey City through a 72-in. Venturi meter. The noise at the river crossing made by the leak continued to increase, and the difference in the quantities, also increased, until the loss was between 5 and 6 million gallons daily, as measured at Boonton and Jersey City.

In the fall of 1907 a diver was again employed to examine the pipe from the outside, and this examination made Oct. 7, 1907, showed that there was a substantial stream of water coming out of the pipe at about Station 1022+50, shown on Fig. 1. The diver reported that the stream coming from the pipe was of sufficient velocity and volume to force his body to one side when he passed in front of it, and that there was a hole in the concrete covering on the side of the pipe about 10 ins. square, and that the velocity was so great that he could not feel of the pipe to determine the character of the injury to the steel plates. The diver's description of the leak and the

*Paper read before American Waterworks Association, at Washington, D. C.

†Engineer Jersey City Water Supply Co., Jersey City, N. J.

quantity of water being lost, convinced us that we should make repairs at once.

It was at first decided that repairs might be made more economically without the aid of air pressure, and plans were made to get at the leak by pumping out the water. This pipe crossing the Hackensack River is in the middle of the Hackensack Meadows, and about two miles from the nearest point that could be reached by wagon road, and at least two miles from the nearest point where power could be obtained. After considering the feasibility of getting electric power to operate the pumps, which would of necessity have to be placed inside the pipe in order to handle the water, it was decided that the cost of getting electric power would be excessive, and the difficulty of getting a steam plant there and handling the exhaust pipes within the main pipe, led us to decide to abandon this method and make the repairs by means of compressed air.

A compressed air plant of sufficient capacity to handle the job, together with the necessary boiler power to operate it, was secured from the O'Rourke Construction Co. of New York, shipped to the river crossing by barge, and set up on the west bank of the river. At about 400 ft. west from the break a 48-in. tee had been placed in the line when it was built, with a main line 48-in. valve on either side of it, and a 48-in. valve on the tee; also a main line 48-in. valve on the east side of the river. This afforded means of getting into the pipe without cutting the main line. An air lock was obtained and fitted to the flange of the valve in the tee, the plant set up and got in working order. About 200 ft. east of the 48-in. branch which afforded a means of entering the pipe, and therefore 200 ft. nearer the river and the break, was a manhole. As soon as the pressure was off the main line, the cover was removed from this manhole, and another cover which had been previously fitted with a 3-in. tapped opening through which a 3-in. nipple was screwed, was put on in its place. From this manhole we then connected a line of 3-in. screw wrought iron pipe, which had been previously prepared in suitable lengths and carried this 3-in. pipe down the 72-in. pipe toward the break as the water was forced out of the 72-in. pipe through the break by the pressure of the air. This 3-in. pipe acted as a discharge for the water after the break has been stopped up and no more water could be forced out that way, and proved of sufficient capacity.

On Dec. 1, 1907, we made the first move towards getting into the pipe to determine the nature of the break. We shut down the main line valve on either side of the river, thus isolating the river crossing, which is about 1,000 ft. in length. These valves were finally closed at about 2 p. m. After these valves were closed the 48-in. valve on the branch was opened and as much water allowed to run out this section of pipe through the airlock as would do so. Then

the airlock was closed and the air compressor was started. No difficulty was met in forcing out the water until it got to such a level in the pipe that the air would escape through the top of the break. As soon as this point was reached the air escaped with such rapidity that no further progress could be made towards forcing out the water. Several schemes were tried before we finally succeeded in plugging up the crack sufficiently to hold the air and force out the rest of the water. It being in the winter time it was exceedingly unpleasant to wade in water up to one's neck and by hand plug up the crack with clay. Large quantities of waste and gasket yarn were floated out on boards in the pipe and the crack partially plugged in this way, but this method was found to be slow and unsatisfactory. Finally the foreman in charge of the work waded out in the water in a diver's suit and succeeded in plugging up the crack with clay, after which there was no further difficulty in forcing out the water sufficiently to allow men to enter and

to make repairs as before, i. e. to rivet on patches with stud bolts, but we now decided that this could not be done without delay and that repairs must be made in the shortest possible time, and the question was, how repairs could be made so that they might be completed in the least possible time. After considerable discussion of various plans proposed, it was decided to put an internal ring in the pipe, and our first thought was to make this ring of cast iron. After considering the subject in all its phases, especially the difficulty of handling the heavy weight of iron that would be necessary, it was finally decided to make the internal sleeve of steel plate. This sleeve was made up of three steel plates, 2 ft. wide by 6 ft. long, as shown by Fig. 2. It was thought that these plates could be bent to form an angle for bolting together, as shown on the drawing, but it was discovered that this could not be done without cracking the plates, and angles were riveted to the plates to form flanges. Set screws were put in the plates to assist in adjusting and holding the sleeve in position in the pipe.

Several materials were considered as filling between the sleeve and the pipe. Pyrocement was one of these; this is a patent cement which will expand upon setting. This cement was rejected as a filling because of the time necessary for its setting, which in that position would have been at least 24 hours before it would have been safe to let water come in contact with it. Lead, in its usual form, was rejected because of the impracticability of pouring the joint completely, and the fact that even if it were possible to pour it, it could not be caulked its entire depth. Lead wool was finally decided upon as the material to be used in filling the joint. This was selected on account of the facility with which it could be handled, the fact that it could be placed in the presence of water, and that it could be caulked in the entire depth of the joint.

After the first examination of the pipe was made, the actual starting of repairs was delayed for several days until arrangements to supply Jersey City with water, while the conduit was out of service, were made, and the repairs proper were begun on Dec. 19, 1907. The water was turned off at 8.45 a. m. on this date, and the pipe finally emptied below the position of the break the necessary tools, sleeve, materials, etc., gotten in the pipe by 6 p. m. During the night the sleeve was placed in position ready for the filling material.

After the sleeve was placed in position, the center of the joint around the row of circumferential rivets of the pipe and where the crack was located, was thoroughly caulked with ordinary gasket yarn smeared with clay, in order to prevent the water working in and getting in around the layers of lead wool which were to follow, and to act as backing for the first layer of lead. Then the filling was continued from either side with lead wool and thoroughly caulked to within about two inches of the

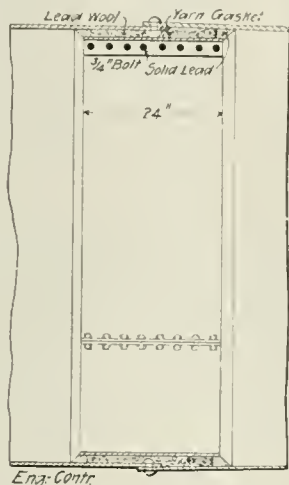


Fig. 2.

examine the pipe thoroughly. It was discovered that the pipe had cracked about three-fifths of the way around, the crack being on top, and open at its widest part from $\frac{3}{8}$ in. to $\frac{1}{2}$ in. This work took all Sunday afternoon, Dec. 1st, all day Monday, the 2nd, and up to 2:30 p. m. on the 3rd, when we finally got down so could make an examination and determine the nature of the rupture in the pipe. At this time we were notified by Jersey City that they were getting short of water, and that we would have to turn the water through this 72-in. pipe again in order to maintain their supply. The water was again sent through the pipe at 6 p. m., Dec. 3.

Owing to the difficulty of maintaining the supply to Jersey City without this 72-in. main being in service, and therefore, the time for making repairs being limited, to practically a 48-hour period, it was seen that it would be utterly impracticable to repair this break in the manner that the first break had been fixed. It had been our intention before examining the break

outside edge of the sleeve. This outside space was filled with strips of solid lead, 3 or 1 ft. long, which had been poured in molds the thickness of the joint, thoroughly caulked, and leaving the sleeve finished in position as shown in detail on the longitudinal sectional elevation, Fig. 2. The work of caulking in the lead wool was begun at 6 a. m., Dec. 20, and carried on continuously until finished, and the water again turned on about 7 p. m. of the same day, making the total time that the conduit was out of service approximately 36 hours. The pipe was tested for leakage when the water was turned on and found to be tight.

Special home-made caulking tools were used in placing the lead wool in the joint. The men who actually made the repairs worked in two shifts of five men and foreman for each; two hours in and two hours out of the conduit, the same men working in this way from start to finish of the job. The men were all from the regular working force of the company, and were selected for their known qualities of endurance, and to their faithfulness is due very largely the successful completion of the job in so short a time.

To Chris McGarry, the general foreman in charge of the work, great credit is due for the careful and complete manner in which he carried out the plans, and provided for all emergencies likely to arise in such an undertaking.

Acknowledgment is hereby made of the assistance and advice given in planning and carrying out this work to John H. Cook, hydraulic engineer of the company; Edlow Harrison, chief engineer of the company; J. Waldo Smith, consulting engineer, and Fred Gubelman, of the O'Rourke Construction Co. of New York.

Of the total of 3,252,506 cu. yds. of material excavated in August, on the Isthmian Canal, the dredges in the Atlantic and Pacific Division took out 1,375,991 cu. yds., states the Canal Record. The following table shows the work done by each dredge:

Name and class of dredge.	Excavation, Cu. yds.	Material.
Ancon (sea-going suction)	335,846	Earth
No. 1 (French ladder)	135,610	Earth
No. 6 (French ladder)	130,210	Earth
Mindi (dipper)	18,620	Rock
Chagres (dipper)	17,931	Rock and earth
16-in. suction	9,943	Earth
No. 82 (20-in. suction)	51,505	Earth
Pacific Division.		
Culebra (sea-going suction)	431,296	Mud
Gopher (sea-going ladder, French)	161,588	Mud and coral rock
No. 82 (French ladder)	144,890	Mud

For the sea-going suction dredges, *Culebra* and *Ancon*, the measurements are scow or bin measurements, but for all other dredges the measurements are made in place by soundings and cross sections.

Contracts have been awarded by the U. S. War Department for the construction of ten torpedo boat destroyers.

Labor Cost of Constructing 74 Brick Vaults for Underground Conduit on One Job.

The standard vault for underground telephone conduit has until recently, when concrete has been used to considerable extent as noted in our issue of August 12, 1908, been usually a vault with concrete bottom and top and brick walls. This is the type of vault for which costs are given

in the accompanying tables 1 to IV, inclusive. These vaults were all built on one job; they comprise only a part of the vault work and have been selected as representing typical work.

Sizes of Vaults.—The sizes of the vaults costs of which are given were No. 2, 4 and 10. These vaults are shown by Figs. 1, 2 and 3, respectively. The specified construction was substantially as follows:

The excavation shall be sufficiently deep

TABLE I.—COST OF CONSTRUCTING 24 NO. 10, BRICK VAULTS FOR UNDERGROUND CONDUIT.

No. of vault.	Cost of teaming.	Cost of excavating.	Cost of mixing concrete and cement.	Cost of laying brick.	Cost of placing floor and top.	Total cost.	Super-vision.	No. hours worked.
1.....	\$3.05	\$30.43	\$2.20	\$23.11	\$7.08	\$65.87	\$5.11	157½
2.....	7.50	24.97	3.97	39.06	7.35	82.67	14.72	173½
3.....	15.00	30.85	3.56	35.48	12.66	97.55	31.26	216
4.....	5.00	42.30	6.68	40.39	32.42	126.79	14.44	419
5.....	2.89	12.20	1.14	21.76	5.47	43.46	6.19	122
6.....	7.15	22.10	1.49	15.78	5.22	52.04	4.48	150½
7.....	6.31	8.75	1.25	20.25	5.22	41.78	3.96	110½
8.....	5.37	14.50	1.12	21.95	5.51	48.43	4.78	118
9.....	7.34	22.00	2.91	27.65	3.54	63.44	6.23	194
10.....	6.96	20.00	3.90	24.50	3.46	58.82	5.18	169½
11.....	6.36	9.42	4.75	22.72	5.34	48.59	5.79	136
12.....	20.91	40.66	12.61	28.90	11.26	114.34	26.83	270½
13.....	20.30	24.33	4.62	28.23	7.54	85.02	16.80	179
14.....	11.75	23.06	7.77	23.69	7.55	79.82	14.91	173½
15.....	19.37	47.48	8.86	21.99	7.75	105.45	33.15	211½
16.....	23.90	21.47	13.61	32.77	5.68	97.43	23.10	187
17.....	19.56	21.29	9.94	36.80	7.12	94.71	24.21	182
18.....	6.94	38.50	6.45	25.56	8.54	85.99	19.10	201
19.....	7.81	37.35	8.08	30.57	7.85	91.66	21.31	238
20.....	12.97	25.00	5.24	20.38	10.23	73.82	17.02	180
21.....	10.97	33.30	7.42	25.71	14.72	92.12	21.37	222½
22.....	18.41	19.67	4.82	21.64	15.61	80.15	11.45	191
23.....	16.46	39.56	4.48	20.96	10.68	83.14	9.47	218
24.....	24.70	30.31	5.40	27.75	8.30	96.46	11.67	225
Total	\$287.28	\$630.50	\$132.39	\$613.60	\$216.10	\$1,909.87	\$352.86	\$4,705½
Average	\$11.97	\$26.25	\$5.51	\$26.82	\$9.004	\$79.58	\$14.70	196.06

Notes:—No. 1, sand and clay, had to sheet on account of spring, surplus earth scattered; No. 2, hard clay; No. 3, hard clay; No. 4, quicksand and water, spring in vaults, had to sheet and put bottom on in sections; No. 5, sand, pumped water all day; No. 6, hard clay, paid bricklayer \$3.50 per day; No. 7, sand; No. 8, sand; No. 9, hard clay; No. 10, hard clay; No. 11, sand, had to sheet; No. 12, quicksand and water, built after conduit was completed; Nos. 13 and 14, macadam on hard clay, built after conduit was completed; No. 15, quicksand and water, special watchman on account of turn in road hiding excavation, built after conduit was completed; No. 16, macadam on hard clay, built after conduit was completed; No. 17, hard clay, rain caused cave in; No. 18, hard clay, built after conduit was completed, caved in, had to sheet; No. 19, hard clay, rain, built after conduit was completed, caved in, had to sheet; No. 20, hard clay, caved in, had to sheet; No. 21, hard clay, built after conduit was completed; Nos. 22 and 23, clay, built after conduit was completed.

TABLE II.—COST OF CONSTRUCTING SIX NO. 2 AND 23 NO. 4 BRICK VAULTS FOR UNDERGROUND CONDUIT.

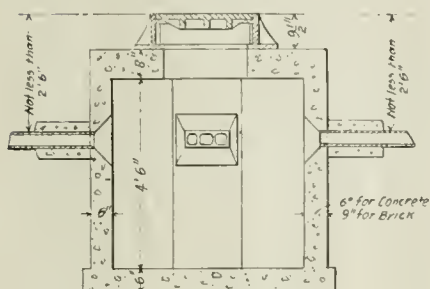
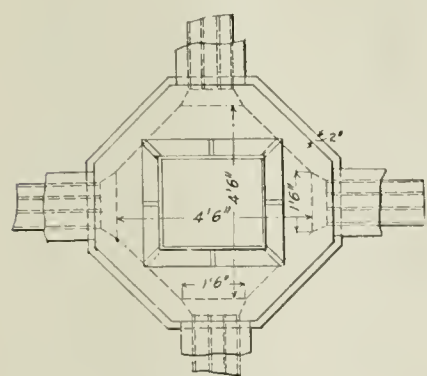
No. of vault.	Cost of teaming.	Cost of excavating.	Cost of mixing concrete and cement.	Cost of laying brick.	Cost of placing floor and top.	Total cost.	Super-vision.	No. hours worked.
1.....	\$2.50	\$3.66	\$2.44	\$8.43	\$2.68	\$19.71	\$1.40	63
2.....	3.06	4.15	1.99	8.21	2.90	20.31	1.43	52
3.....	4.00	10.82	.88	23.40	5.77	44.87	2.83	125
4.....	2.85	4.10	1.40	5.21	2.35	15.91	1.44	46½
5.....	3.02	6.68	.97	12.07	2.47	25.21	1.59	71½
6.....	2.41	2.96	1.00	20.75	3.86	30.98	1.93	88
Total.....	\$17.84	\$32.37	\$8.68	\$78.07	\$20.23	\$156.99	\$10.62	446
Average	\$2.97	\$5.395	\$1.447	\$13.01	\$3.34	\$26.165	\$1.77	74.3
1a.....	\$5.13	\$4.54	\$5.23	\$9.43	\$4.79	\$29.12	\$6.22	70½
2a.....	3.37	3.40	4.67	9.58	3.85	24.87	4.64	56¾
3a.....	3.84	5.33	3.07	10.42	4.03	24.69	4.88	58¾
4a.....	4.14	3.56	2.13	13.86	3.78	27.47	5.53	61¼
5a.....	5.10	3.56	1.85	11.12	3.27	24.90	4.59	55
6a.....	4.53	4.68	3.83	11.17	3.78	27.99	5.36	58¼
7a.....	3.74	5.36	4.21	12.55	3.52	29.38	5.65	65¾
8a.....	2.59	3.56	2.83	10.51	3.79	23.28	4.62	52¾
9a.....	3.77	3.56	2.08	9.35	3.34	22.10	4.20	49½
10a.....	3.77	6.40	1.85	9.62	3.14	24.78	5.17	56½
11a.....	3.40	2.40	2.31	13.45	2.54	24.10	5.66	49
12a.....	10.65	3.56	1.88	12.20	2.20	30.49	6.30	52
13a.....	8.50	3.59	1.36	12.79	1.55	27.79	5.89	51½
14a.....	5.61	4.66	2.97	10.83	4.36	28.43	5.93	64
15a.....	4.87	5.12	2.25	11.00	3.53	26.77	5.94	60
16a.....	5.47	10.21	3.11	12.22	6.45	37.46	8.00	81
17a.....	4.70	5.54	4.18	10.28	7.82	32.52	6.78	66½
18a.....	3.88	9.00	3.69	11.42	4.50	32.43	7.04	76
19a.....	1.62	12.79	3.32	11.40	5.18	34.31	7.61	90
20a.....	7.93	11.82	5.42	15.10	4.16	41.43	8.47	105
21a.....	14.40	12.78	3.59	13.38	8.21	52.39	11.54	94
22a.....	10.52	9.64	3.00	12.84	8.16	44.16	8.99	87½
23a.....	12.87	10.04	4.30	14.77	7.90	49.88	10.17	89
Total.....	\$134.40	\$143.10	\$73.07	\$269.29	\$103.88	\$723.74	\$149.11	1,553½
Average	\$58.13	\$62.22	\$3.18	\$11.71	\$4.52	\$31.47	\$64.83	67.5

Notes:—Nos. 1 and 2, sand, paid bricklayer \$3.50 per day; No. 3, quicksand and water, had to sheet and pump and paid bricklayer 80 cts. per hour; No. 4, sand, paid bricklayer \$3.50 per day; No. 5, sand, paid bricklayer 80 cts. per hour; No. 6, sand, paid bricklayer \$3.50 per day; No. 1a to 23a, very hard clay; Nos. 1a to 15a, built along with conduit, mixing done by machine; Nos. 16a to 23a, caved in, built in rear of conduit.

to bring the top of the vault 17½ ins. below street grade and sufficiently wide and long to give a clearance of 6 ins. outside of the brickwork all around the vault, ex-

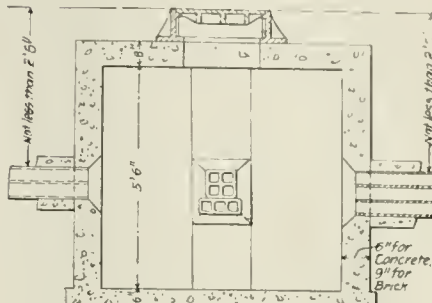
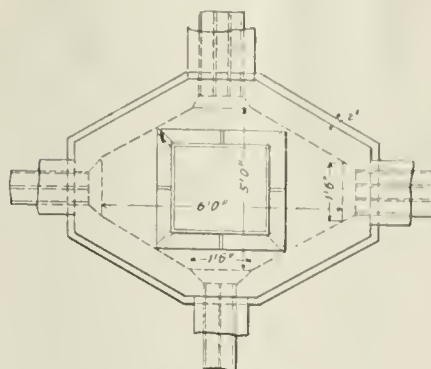
cept in stiff clay when the excavation may be made to the outside dimensions of the vault. In constructing the vault the bottom shall first be tamped and the concrete

bottom placed and tamped in one layer sufficiently wide and long to project, all around, 2 ins. beyond the foundation courses of brick. The walls shall be of



Eng. Contr.

Fig. 1.



Eng. Contr.

Fig. 2.

cept in stiff clay when the excavation may be made to the outside dimensions of the vault. In constructing the vault the bottom shall first be tamped and the concrete

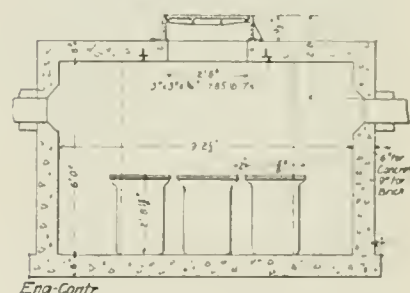
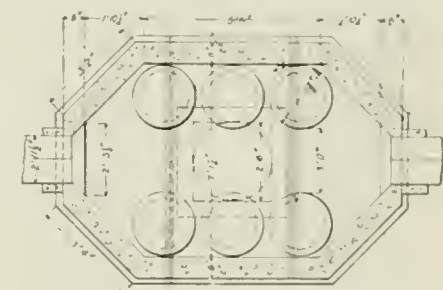
hard burned brick laid in cement mortar with ½-in. horizontal and ⅜-in. vertical joints. Walls shall be 9 ins. thick, with every sixth course of bricks laid as head-

ers. Mortar shall be mixed on closely laid timber platforms or in wooden boxes. The sand shall be spread 2 ins. thick and the cement evenly distributed over its top and the mass turned three times dry with hoes. Water shall be added to make a stiff paste and the mass turned again three times with hoes. Mortar shall be used within 30 minutes after mixing and shall be 1 cement and 3 sand.

Organization and Wages.—The vault gang consisted of 12 to 15 men, an assistant foreman and a team. The wages paid were as follows:

Per 9 hr. Day.
Foreman \$3.50 to \$4.00
Assistant foreman 2.50 to 3.00
Timekeeper 2.00 to 2.50
Watchman 2.00
Waterboy 1.00
Laborers 2.00
Teams 5.00
Bricklayers 65 to .75 cts. per hour

Costs.—In Tables I to IV the cost of placing floor and top includes the cost of



Eng. Contr.

Fig. 3.

setting frame and cover and of resurfacing the street. The cost of supervision includes cartage and board; it is given separately for sake of study but the total cost includes the cost of supervision. The work given in Tables I and II was done by one foreman, that given in Table III by another and that given in Table IV by another.

We are indebted for these cost data to Mr. Clarence Mayer, Chicago, Ill., under whose direction the cost records were collected by special cost men on the job.

The management of the German railroads has ordered a higher speed on the main lines, so that instead of 20 kilometers (55.92 miles), as heretofore, it will be 100 kilometers (62.13 miles) per hour.

The Third Biennial meeting of the American Public Works Association will be held Sept. 29 and 30 at Battery Park Hotel, Asheville, N. C.

TABLE III.—COST OF CONSTRUCTING NINE NO. 4 BRICK VAULTS FOR UNDERGROUND CONDUIT.

No. of vault.	Cost of teaming.	Cost of excavating.	Cost of mixing concrete and cement.	Cost of laying brick.	Cost of placing floor and top.	Total cost.	Super-vision.	No. hours worked.
1.....	\$4.25	\$11.48	\$6.84	\$9.55	\$4.73	\$36.85	\$8.30	76½
2.....	4.20	8.00	1.58	31.58	4.03	52.39	2.84	101
3.....	5.00	4.22	.62	17.56	2.35	29.73	3.23	64
4.....	4.00	11.28	1.58	29.82	4.97	51.65	10.58	117
5.....	4.50	6.20	1.79	33.42	2.00	47.91	13.34	95
6.....	8.00	10.13	.94	18.84	2.94	40.85	10.01	79
7.....	10.50	13.92	1.64	29.42	5.32	60.80	8.65	123
8.....	6.00	8.33	.97	18.32	2.24	35.86	7.58	72
9.....	3.50	5.18	2.60	22.68	3.92	37.88	7.20	82½
Total	\$49.95	\$78.74	\$18.56	\$214.19	\$32.48	\$393.92	\$71.73	810
Average	\$5.55	\$8.75	\$2.06	\$23.80	\$3.61	\$43.77	\$7.97	90

Notes:—These vaults were built after the conduit was completed; there was more supervision than was necessary on account of not wishing to lay off assistants until another section was completed. No. 1, hard clay; No. 2, hard clay, bricklayer very slow; No. 3, hard clay; Nos. 4 to 9, hard clay, slow bricklayer, rain, very wet, hard to pump.

TABLE IV.—COST OF CONSTRUCTING SEVEN NO. 4 AND FIVE NO. 10 BRICK VAULTS FOR UNDERGROUND CONDUIT.

No. of vault.	Cost of teaming.	Cost of excavating.	Cost of mixing concrete and cement.	Cost of laying brick.	Cost of placing floor and top.	Total cost.	Super-vision.	No. hours worked.
1.....	\$3.50	\$9.24	\$9.71	\$14.25	\$5.48	\$42.18	\$13.00	115½
2.....	3.50	12.41	4.11	10.49	5.00	35.51	11.99	79½
3.....	3.50	10.09	4.91	12.05	5.80	38.35	12.93	86
4.....	6.17	9.11	2.96	7.36	5.00	30.60	8.24	69½
5.....	7.34	11.87	5.28	10.17	3.48	38.11	10.27	79
6.....	10.90	7.07	4.55	9.55	3.21	35.28	9.01	65½
7.....	10.60	6.42	3.99	12.59	4.44	38.04	9.72	78½
Total	\$45.51	\$66.24	\$35.51	\$76.46	\$32.41	\$256.13	\$75.19	573½
Average	\$6.50	\$9.46	\$5.07	\$10.92	\$4.65	\$36.59	\$10.74	81.9
1a.....	\$16.65	\$39.44	\$6.44	\$24.14	\$10.76	\$97.37	\$20.69	252½
2a.....	16.58	18.51	8.22	26.58	11.10	80.99	16.28	192
3a.....	23.71	46.25	7.55	31.02	18.87	127.40	32.37	262
4a.....	30.78	36.71	5.63	18.32	15.63	107.07	28.32	213½
5a.....	15.00	11.40	7.98	35.16	18.12	87.66	28.33	193
Total	\$102.72	\$152.31	\$35.82	\$135.22	\$74.42	\$500.49	\$125.99	1,143
Average	\$20.54	\$30.46	\$7.16	\$27.04	\$14.88	\$100.10	\$25.20	228.6

Notes:—Nos. 1 to 5, hard clay; Nos. 6 and 7, hard clay, had to haul brick from another vault; No. 1a to 5a, hard clay; No. 3a, concrete vault built by mistake and torn out, had to change conduit.

Method and Cost; Some Old; Some New.

Macadam Construction at Termini and Intersections.—Macadam roads are often damaged at their termini and at intersections with clay roads from having the tenacious clay of the mud roads sticking to wheels passing from the latter to the former dropped on their surface. This dropping of clay usually causes a picking up process, converting the surface into a series of undulations. At intersections and ends of macadam roads where this condition is likely to ensue 3-in. stone is often placed on the surface of the connecting road for a distance of 80 to 100 ft. This rough surface will cause the wheels to drop their burden of clay before reaching the macadam road and the section of clay road thus treated will eventually be cemented into a good surfaced road.

Per Cent of Engineering for Road Construction.—During 1905 and 1906 there were built in New Castle County, Delaware, 7.48 miles of macadam road and 2.9 miles of gravel road. The per cent of engineering expenses on these roads varied from 2 per cent to 3.7 per cent, the average being 2.2 per cent. In Madison County, Tennessee, 24¼ miles of macadam roads were built at a cost of \$115,681.71. The cost of engineering, superintendence and surveys was \$7,016.35, or about 6 per cent of the total amount expended. In Pennsylvania the average cost of inspection on roads built for the State Highway Department has been 3 per cent of the cost of the road and the average of engineering expenses has been 2 per cent. In New Jersey the per cent of engineering expenses to the total cost on state roads constructed in 1907 varied from 4.6 to 2.4, the average being 3.2 per cent.

Rolling Snow on Roads.—For over 15 years the State of Vermont has been rolling the snow on its public roads. Many other states have now taken up the practice. The advantage of rolling over methods of removing snow is that a hard, wide, level track is made, which permits teams to pass one another without danger or inconvenience, the snow being compacted for a width of 8 or 10 ft., and it is therefore smooth on either side of the beaten path. Snow rollers are usually from 5 to 5½ ft. in diameter, built in two sections of from 4 ft. to 5½ ft. in length, with as little space as possible between the two sections. The roller should be constructed of two sections of such length as will permit it to pass readily within the rails of bridges in the town. Many rollers are built with a snub pole, which is attached to a bob-sleigh, and to which from four to six horses are attached. The first rolling should take place as soon as 6 to 8 ins. of snow have accumulated on the surface of the road, and again upon the accumulation of every additional 6 to 8 ins. When drifts are encountered the snow should be leveled be-

fore the roller is drawn over it, thus keeping an even surface. There should be a roller to each 25 or 30 miles of road in a town. The cost of rolling is from 25 cts. to 50 cts. per mile.

Hauling in Road Construction.—In the construction of a system of macadam roads in Madison County, Tennessee, it was found that with the ordinary farm wagon, provided with slats and sideboards, and holding 1 cu. yd., that the average team would travel in a 10-hour day an average distance of 24 miles. To accomplish this distance required continual urging of the team. The price paid for wagon, team and driver was \$2.50 and the haul being only one way, the cost per cubic yard per mile for hauling was therefore 20.83 cts. During the fall months, the weather being cool, a different plan was tried, a 10-hour day being based on 28 miles of travel for each team at the above named rate. Signboards placed along the road at regular intervals marked the time in hours and minutes allowed the owner of each team for material delivered between these points, a record being kept by the foreman in charge. It was found that some drivers pushed their teams exceedingly hard and forced them to travel as much as 40 miles, so that, at the close of the second day's work, the team was laid up on account of overwork. On the other hand, a few team owners fell below the former earnings, but solely on account of inferior teams and incompetent drivers. The distance of 28 miles with favorable weather conditions was found to be all that a good team could cover in 10 hours, and be able to keep at it continually. The cost of hauling at this rate was 17.86 cts. per cubic yard per mile of actual haul.

"Home-Made" Plant for Putting in Coffey Dam.—In the construction of the foundations for the power house of the hydro-electric plant at the University of Iowa most of the work was done by students in the Engineering Department under the direction of one of the professors. The coffer dam was 30 ft. x 60 ft., and the working plant for constructing it was rather simple, yet effective. For driving the piles, a variable speed 8-hp. motor from the electrical laboratory of the college was mounted on a frame together with the drum from a steam hoisting engine. This drum was belt connected to the motor and had a friction clutch and brake. The pile driver consisted of two 1x6 leads, 20 ft. in length, well braced. The hammer weighed 1,000 lbs. and the motor at slow speed operated it rapidly and effectively. When it was desired to sharpen the sheet piles or make a special pile the motor belt was changed from the hoisting drum to a circular saw, and the motor run at its highest speed. The sheet piles consisted of three thicknesses of cypress plank, each plank 11½x1¾ when surfaced on both sides and edges. A 4-in. tongue and groove was found to work well, making a very tight joint. Ten ¾ in. bolts were used for each pile, and the points

were shod with thick hoop iron. Before driving, the groove of each pile was greased with cheap car track grease, it being found that this materially increased the ease with which the piles could be placed and kept in position. It was also discovered later that the grease made the coffer dam tighter and the piles much easier to pull. The piles were made very carefully, and were sharpened. For pumping out the coffer dam a Gould 6-in. centrifugal dredging pump was purchased and a fourth-class threshing machine rented.

Cost of Superintendence of Irrigation Canals.—The following table showing the cost per acre for superintendence and distribution of water from the irrigation canals of the State of Colorado has been taken from the 13th biennial report of the State Engineer. The irrigated land in Colorado is divided in five divisions, each under the supervision of a division engineer. Each division is subdivided into districts, each district being under the supervision of a water commissioner, who is assisted by deputy water commissioners. Water commissioners receive \$5 per day, and deputy commissioners \$2.50 per day when working. The table was compiled from the reports made by the water commissioners and shows the cost of superintendence and ditch riders per acre. This is really the cost of distributing the water. The table shows the cost of superintendence for the entire district. The several canals in the district may have a greater variation in cost per acre than the district themselves. The table follows:

Water District No.	Cost per acre for Superintendence and distribution of water, 1905	Cost per acre for Superintendence and distribution of water, 1906.
1	\$0.09	\$0.16
2	0.15	0.13
4	0.32	0.21
5 .....	....	0.06
6	0.09	0.09
7	0.14	0.16
8	0.50	0.30
9	0.21	0.20
12 .....	....	0.23
14 .....	....	0.11
17 .....	....	0.14
21	0.14	0.12
67 .....	....	0.17

The Chilean Government has awarded the contract for the improvement of the harbor of Valparaiso to the firm of Batignolles, Fould & Co., a French concern. The work will include a breakwater, 3,281 ft. long; docks, 6,562 ft. long, at which ships can touch; rock work extending the docks toward Fuerte Andes; roads to connect the docks; coal docks, and all the machinery and equipments for the works. The work is to be entirely completed in seven years, and the contract price is about \$19,500,000.

The Weights of Steel Bridges for Highway, Railway and Electric Railway, Spans of 10-ft. to 300-ft.

In our issue of Sept. 2 we gave the amounts of materials and the costs of some 30 concrete highway and railway bridges. In this issue and in subsequent issues we shall give similar data for use in estimating the approximate cost of steel bridges. In this issue we shall confine ourselves to the weights of standard bridges on the Northern Pacific Ry. and on the Santa Fe Ry., followed by Tyrrell's formulas for calculating the weights of bridges of moderate size.

In later issues, data (including costs) as to numerous specific bridges will be given, including swing bridges, lift bridges, arch and suspension bridges.

Weights of Standard Bridges, A. T. & S. F. Ry.—These single track bridges are designed to carry a moving load of two 139-ton consolidation engines, followed by a train weighing 3,200 lbs. per lin. ft., according to specifications drawn in 1902.

Estimated Weights of Single Track Through Pin Truss Bridges: Atchison, Topeka & Santa Fe Ry.

Span c. to c. of pins. Ft.	Weight per span. Lbs.	Class.
100.....	193,700 ¹	D
103.....	183,300	D
110.....	195,300	D
124.....	236,800	D
126.....	283,900 ²	D
128.....	244,300 ³	..
130.....	251,500	..
130.....	258,200 ⁴	..
134.....	263,200	C
149.....	295,500	C
149.....	347,500 ⁵	D
160.....	341,900	D
164.....	346,100	C
172.....	371,700	C
200*.....	499,500 ⁶	C
210†.....	490,400 ⁷	C
260.....	702,400 ⁸	C
300.....	914,500 ⁹	C

Note—All truss spans of 140 ft. and less have stiff bottom chords.

*Soft steel. †Medium steel.

¹, ² and ³ stiff bottom chord carries floor; ⁴ 130-ft. span shortened; ⁵ span for 5° curve; ⁶ parallel chords; ⁷, ⁸, ⁹ chords not parallel.

C—Deep floors. D—Shallow floors.

Estimated Weight of Single Track Plate Girder Bridges: Atchison, Topeka & Santa Fe Ry.

Span.	Deck Girders		Through Girders	
	Class A	Class B	Class C	Class D
Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
26 ft.	12,800	17,900		
30 ft.	16,000	23,900		24,300
32 ft.	17,500	25,800		27,100
34 ft.	20,000	28,600		
36 ft.	21,600	32,100		44,700
40 ft.	24,300	36,600		49,600
40 ft. 10° curve	24,600			
42 ft.	26,000	39,200		
44 ft.	28,300	36,000		
48 ft.	35,500	45,000		63,400
48 ft. 5° curve.				64,100
48 ft. 10° curve.				64,400
50 ft.	36,900	49,800		68,600
52 ft.	40,900	50,000		73,000
54 ft.	42,500	53,500		76,800
58 ft.		58,500		
60 ft.	51,500	62,400	80,200	90,400
60 ft. 5° curve.			80,600	91,600
60 ft. 10° curve			81,100	92,600
62 ft.				93,600
64 ft.	56,100	66,800	82,200	97,700
64 ft. 5° curve.			82,100	
64 ft. 10° curve.			82,700	
66 ft.	58,600			
70 ft.	68,800	83,300	105,000	112,000
70 ft. 5° curve.			105,800	113,100
70 ft. 10° curve			106,300	113,300
75 ft.	78,500	94,800	113,200	129,200
75 ft. 5° curve.			113,700	
75 ft. 10° curve			114,000	
80 ft.*.....	88,500		121,100	136,400
90 ft.*.....	110,600		159,900	172,200
100 ft.	133,600			
105½ ft.			218,500	

*Weights given for girders Class C and D are for round ended girders.

Classes A and C are designed in the most economic manner and are used wherever possible. Class B is for spans of the least depth consistent with good service. Class D is for spans with shallow floors.

Classes B and D are used only where it is less expensive to use these shallow bridges than to change the grade line. The tabular weight is the calculated weight plus 2½%. If the shipped weight is in excess of the tabular weight the excess is not paid for.

Weights of Standard Bridges, N. P. Ry.—In 1899 standard plans were made for Northern Pacific Ry. bridges. The assumed live load was two 116-ton locomotives, followed by 4,000 lbs. per lin. ft. of track. The following table gives the approximate weights of single track steel bridges, the weights being given closely enough for purposes of preliminary cost estimates.

I Beam:

Span in ft.	Weight in lbs.
20.....	10,000
30.....	20,000

Deck Plate Girders:

25.....	13,000
35.....	20,000
40.....	25,000
50.....	37,000
60.....	50,000
70.....	63,000-73,000
80.....	96,000
90.....	113,000
100.....	133,000

Through Plate Girders:

40.....	40,000
50.....	53,000
60.....	70,000
70.....	88,000-98,000
80.....	118,000
90.....	112,000
100.....	170,000

Deck Lattice:

110.....	150,000
120.....	165,000

Through Lattice:

110.....	174,000
120.....	215,000

Deck Pin Spans:

130.....	202,000
140.....	220,000
150.....	244,000
160.....	261,000
170.....	297,000
180.....	330,000
190.....	360,000
200.....	392,000

Through Pin Spans:

130.....	210,000
140.....	230,000
150.....	252,000
160.....	280,000
170.....	303,000
180.....	340,000
190.....	374,000
200.....	410,000

Formulas for Weights of Railway Bridges.—Mr. Tyrrell gives the following formulas: All weights (H') are per lineal foot of single track bridge for steel only; units 10,000 to 12,000 lbs. per sq. in. The

live loads assumed are two engines weighing 100 tons each, and 1,000 lbs. per lin. ft. of track.

Deck plate girder bridge, $H' = 100 + 9 L$

Deck lattice girder

bridge $H' = 100 + 8 L$

Half through plate girder

bridge with floor..... $H' = 100 + 12 L$

Same with ties on

shelf angle $H' = 200 + 8½ L$

Same with trough

floor $H' = 600 + 10 L$

Riveted through truss

bridge $H' = 100 + 6 L$

Riveted deck truss

bridge, ties on top chord, $H' = 200 + 7 L$

Pin through truss bridge, $H' = 100 + 5½ L$

Pin deck truss bridge

with stringers $H' = 100 + 6 L$

Pin deck truss bridge,

ties on top chord..... $H' = 300 + 6 L$

H' = weight of steel, lbs. per lin. ft.

L = span in feet.

Railway Trestles.—Assumed loads same as above; weight of spans as above. Weight of bents and bracing is 9 lbs. per sq. ft. of side profile from ground to base of rail.

Mr. Tyrrell also gives the following formulas for the weights of single track railway bridges, for spans of 30 to 230 ft., designed according to Cooper's E 50 loading:

Deck plate girders, $H' = 100 + 12 L$

Through plate girders, $H' = 500 + 12 L$

Through truss spans, $H' = 600 + 7 L$

H' = weight in lbs. per lin. ft.

L = span in feet.

Add 90% for double track bridges.

Johnson's "Modern Framed Structures" gives the following formulas for the same loading:

Deck plate girders, $H' = 150 + 12 L$

Through plate girders, $H' = 500 + 12 L$

Through truss spans, $H' = 650 + 7 L$

Cooper's E 50 loading provides for a train of two "consolidation engines" (177½ tons each, including tender), followed by a uniform live load of 5,000 lbs. per lin. ft.

Formulas for Weight of Electric Railway Bridges.—Mr. H. G. Tyrrell gives the following formulas for weight of single track electric railway bridges of 5 ft. to 200 ft. span. The weights include steel only, without safety stringers. The live load is assumed to cover the span from end to end. The details are figured for riveted joints

I-beam spans of 5 to 20 ft., $H' = 50 + 5 L$

For truss spans of 10 to 200 ft., loaded with 15-ton cars, or 1,000 lbs. per ft., $H' = 200 + 0.8 L$

For truss spans of 20 to 180 ft., loaded with 30-ton cars, or 2,000 lbs. per lin. ft., $H' = 250 + 1.5 L$

For deck plate girder spans, loaded with 2,000 lbs. per lin. ft., $H' = 30 + 5 L$

H' = weight of steel per lin. ft.

L = span in feet.

Electric railway trestles: Weights of spans same as above; weights of bents and bracing is 6 lbs. per sq. ft. of side profile from ground to base of rail.

Formulas for Weight of Highway

Bridges. Mr. H. G. Tyrrell gives the following formulas for the weight of steel in highway truss bridges:

$$\text{With sidewalks, } W = 2.8 + \frac{L}{11.3}$$

$$\text{Without sidewalks, } W = 5 + \frac{L}{9.5}$$

L = length of span in feet.

W = weight of steel per sq. ft. of floor, including both carriageway and walk. The weight includes bracing and shoe plates, but not joists or floor. These formulas were based upon designs of through truss spans from 50 to 150 ft., for roadways ranging from 14 to 20 ft. wide. The trusses are riveted. The live load assumed was 80 lbs. per sq. ft. for trusses and 100 lbs. per sq. ft. floor beams, or a 6-ton wagon. These bridges have timber joists and a floor composed of two layers of plank.

The following formulas are for plate girder highway bridges having 16 to 24 ft. roadway and 20 to 80 ft. span, loading same as above.

$$\text{Through plate girder, } W = 3 + \frac{L}{1.25}$$

$$\text{Deck plate girder, } W = 2.1 + \frac{L}{5}$$

W = weight of steel per sq. ft. and does not include the timber stringers and plank floor.

For highway bridges with solid floors (assumed dead weight of floor, 150 lbs. per sq. ft.), Mr. Tyrrell gives the following formulas:

$$\text{Deck plate girder bridges } W = 3 + \frac{L}{2.6}$$

$$\text{Half through girder bridges } W = 3 + \frac{L}{2.4}$$

$$\text{Truss bridges } W = 3 + \frac{L}{4}$$

The work of deepening the Manchester, England, ship canal to a uniform depth of 28 ft. from Eastham to No. 9 dock at Manchester, involving over three years' continuous work and a heavy expenditure, has been completed.

A large coal handling plant containing novel features is to be built at Philadelphia. One of the features of the plant is a machine to take a boat out of the water, elevate it about 60 ft. in the air, and turn it upside down to discharge the coal. The coal after being discharged may be delivered into other vessels or conveyed into storage. Means are also provided for taking coal out of storage and delivering it into vessels. Provision is made for screening the coal and handling it with minimum breakage. The McMyler Mfg. Co., of Cleveland, O., has the contract for the plant.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0880. **Contractors' Machinery and Supplies.** W. M. Pattison Supply Co., Cleveland, O.

This is a special 276-page catalog of machinery and supplies used by contractors. Practically everything generally used in contracting work is listed with illustrations, tables of sizes, capacities, etc. There is also a full index. The catalog is one that every contractor should have on file.

No. 0881. **Hoisting Engineers.** S. Flory Manufacturing Co., Bangor, Pa.

The line of hoisting machinery manufactured by this company is generally well known to contractors. This catalog lists practically the full line with tables of sizes and capacities, brief descriptions and illustrations. The catalog contains 170 large pages and has a complete index. Contractors and others having use for steam and electric hoists, derricks, cableways, dredging machinery, etc., should secure a copy.

No. 0882. **Reinforced Concrete Pipe.** Reinforced Concrete Pipe Co., Jackson, Mich.

This very handsome 68-page pamphlet contains, besides many excellent illustrations of concrete pipe sewer work, a general description of the construction of the special pipe made by the above company, the claims of this pipe for sewer work and many testimonials of its successful use. The pamphlet should be secured by city engineers for study and reference.

No. 0883. **Power Pumps.**—Dean Bros., Indianapolis, Ind.

This 40-page catalog, known as No. 71, illustrates and describes the numerous styles and sizes of power driven pumps manufactured by this company. This company also makes steam driven pumps.

No. 0884. **Slide Rule.**—M. J. Eichhorn, Electrical Engineer, 5759 Aberdeen St., Chicago, Ill.

A leaflet devoted to a description of this trigonometric slide rule. It is meant to be supplemental in its use to the Mannheim rule, being graduated for the solution of triangles. The face of the rule is arranged for the solution of the formula:

$$C^2 = A^2 + B^2 - 2A \times B \cos C.$$

No. 0885. **Industrial Railways.**—Arthur Koppel Co., 1635 Machesney Bldg., Pittsburg, Pa.

This 18-page catalog, well printed and artistic in appearance, is given over to illustrating and describing the use of Koppel dump cars and industrial railways for contracting work, such as excavating earth and rock, street and road work, railroad and reservoir construction and concrete work. This catalog will be found of interest to contractors.

No. 0886. **Concrete Mixers.**—Nims Concrete Machinery, Philadelphia, N. Y.

An excellent 16-page catalog of this double cubical mixer. This mixer is the result of a contractor's experience with other machines. Seeing their deficiencies in his daily use of mixers, he invented this one, in which it is claimed that many objectional features have been eliminated. The working of the mixer is described and illustrated and also the loading and measuring device. The catalog also shows the adaptability of the mixer to various kinds of work.

No. 0887. **Ore and Coal Handling Plants, Grab Buckets.**—Andresen-Evans Co., Monadnock Block, Chicago, Ill.

This 16-page pamphlet is an unusually good example of descriptive catalog writing. The description of the special grab bucket being advertised is full and clear and the comparison between grab bucket and clam shell bucket operation is interesting. Besides the special grab bucket, the pamphlet describes the Anderson-Evans conveyor bridge and the Anderson-Evans unloading and storage plant. The pamphlet is worth securing.

No. 0888. **Filter Presses.**—William R. Perlin & Co., Chicago, Ill.

This 32-page pamphlet illustrates and lists

the full line of filter presses, engines and pumps made by the firm named. These presses are made in all sizes for all uses.

No. 0889. **Concrete Chimneys.**—Wm. G. Hartman Cement Co., Philadelphia, Pa.

This circular gives views of a number of handsome concrete chimneys built of the Old Dominion Portland Cement sold by the above-named firm.

No. 0890. **Reinforced Concrete Slab Test.**—Trussed Concrete Steel Co., Detroit, Mich.

Reprint, with diagrams and tables, of official report of a load test made on a reinforced concrete slab 12 ft. 1 in. by 10 ft. 2 in. The test was made by Prof. Peter Gillespie of the Faculty of Applied Science of the University of Toronto.

No. 0891. **Elevating, Conveying and Power Transmitting Machinery.**—Weller Mfg. Co., Chicago, Ill.

This is a general catalog of 510 pages illustrating and listing with tables and descriptive text all of the full lines of machinery, supplies and tools made by the above company for grain elevators, flour mills, refineries, cement and phosphate works, etc., etc. The catalog is cloth bound and fully indexed and should be had by everyone using elevating and conveying machinery.

Personals.

Mr. C. L. de Muralt has been reappointed Professor of Electrical Engineering at the University of Michigan for the coming year.

Mr. J. Walter Ackerman has resigned his position as Resident Engineer of the Ithaca Street Railway, of Ithaca, N. Y., to become Superintendent of the water works system of the city of Auburn, N. Y.

Messrs. Andrew J. McCabe, A. C. Spencer and C. M. Johns have organized the McCabe Construction Co., of Portland, Ore., and will engage in railroad construction work in the states of Oregon, Idaho and Washington.

Mr. G. J. Ray, formerly Division Engineer on the Delaware, Lackawanna & Western R. R., has entered the employ of Timothy Burke, a railroad contractor, who has the contract for Section No. 1 of the Lackawanna cut-off in New Jersey.

Mr. A. R. Cook, Division Engineer of the Northern Pacific Ry., with headquarters at Tacoma, Wash., has been appointed Engineer in Charge of Maintenance of Way of the lines west of Trout Creek, with headquarters at Tacoma. Mr. B. L. Crosby succeeds Mr. Cook.

Mr. Frank M. Williams has been nominated as the Republican candidate for State Engineer and Surveyor of New York. Mr. Williams at present is Resident Engineer in the New York State Engineer's Department. He was graduated from Colgate University in 1895 and is 35 years old.

Mr. R. C. White has been appointed Division Engineer of the Memphis Division of the St. Louis, Iron Mountain & Southern Ry., succeeding Mr. S. B. Hanna, who has been appointed Division Engineer of the Missouri Division, with office at De Soto, Mo. Mr. Hanna succeeds Mr. E. C. Welch, transferred.

Gardner D. Hiseox, author of a number of technical books, died Sept. 13 at his home in East Orange, N. J. Mr. Hiseox was Engineer for the Ingersoll Rock Drill Co., now the Ingersoll-Sergeant Drill Co., in 1886-90. He was the author of "Compressed Air and Its Application," "Modern Steam Engineering" and "Hydraulic Machinery."

P. Arthur Irwin, Consulting Engineer to the Baltimore & Ohio R. R., died suddenly Sept. 12, at Irwin-on-the-James, Va. He was at one time Chief Engineer of the Western Maryland R. R., and later President of the road. He entered the service of the engineering corps of the Baltimore & Ohio R. R. in 1883 and rose to the position he occupied at the time of his death.

Mr. E. A. McFarland has resigned his position as Chief Engineer of the Sonora Ry., the Cananea, Yaqui River & Pacific, the Arizona Eastern, the Gila Valley, Globe & Northern, the Arizona & Colorado, the Maricopa & Phoenix and the Phoenix & Eastern. Mr. R. L. Drane, Assistant Chief Engineer, will for the present act as Chief Engineer, reporting to Mr. Epes Randolph, President.

Mr. Philip S. Farley, Assoc. M. Am. Soc. C. E., has been nominated by the Democratic party as its candidate for the position of State Engineer and Surveyor of New York. Mr. Farley has been engaged in private engineering work in New York City and vicinity, having his office in Long Island City. In 1906 he was made Chairman of the Jamaica Bay Improvement Commission. He was graduated as a civil engineer from the Cooper Union in New York, in 1897, and is 36 years old.

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The Commercial Value of Cements of Superior Fineness.

In cements a superior degree of fineness is supposed to have a definite commercial value. What is the amount of this value? An interesting attempt to answer this ques-

tion is made in the paper by Mr. Richard K. Meade, Chemical Engineer, reprinted in another column of this issue. We believe that every cement user can study this paper with benefit to his knowledge of the material with which he works.

The present standard of fineness is that, say, 90 per cent shall pass a 100-mesh sieve and that 75 per cent shall pass a 200-mesh sieve. Mr. Meade considers that grinding to 90 per cent through a 200-mesh sieve is about the limit of fineness commercially that our present cement grinding machines are capable of. To produce commercially, cement so fine that 100 per cent will pass a 200-mesh sieve requires improved grinding machinery. These figures set the physical limits of the problem as they exist at the present time.

The properties which are of chief importance from the viewpoint of cement as a structural material are: Soundness, activity or time of set, and tensile strength. What is the commercial value of superior fineness—say an increase from 75 per cent to 90 per cent through a 200-mesh sieve—in respect to each of these properties? If we can answer this question somewhat definitely we shall be able to figure on the remainder of the problem.

So far as soundness is concerned, Mr. Meade demonstrates that we may consider superior fineness of grinding as of no commercial importance. Soundness of equal degree can be guaranteed by other means at less cost than by fine grinding.

In respect to time of setting, Mr. Meade considers that superior fineness up to 90 per cent through a 200-mesh sieve will have no more effect than a slight quickening of the activity. If still finer grinding, say to 100 per cent through a 200-mesh sieve, is required, then there must be a readjustment of the composition and of the degree of burning or else the time of setting will be quickened so much as to make it unfit for use. We may, therefore, regard superior fineness up to the commercial limit of fineness of our present grinding machinery as of no commercial value or loss so far as time of set is concerned.

This leaves us for consideration only the commercial value of superior fineness in respect to tensile strength. The tensile strength of neat cement is reduced by finer grinding, but as cement is seldom used except mixed with sand to make mortar, this reduction is of no significance. The strength of mortar is increased by fine grinding of the cement. Mr. Meade's figures show that a 1-1 mortar of cement ground so that 90 per cent passes a 200-mesh sieve is as strong as a 1-3 mortar of cement ground to the present standard of 80 per cent through a 200-mesh sieve. This means that 1 bbl. of the finer cement is equivalent to 1 1/4 bbls. of the coarser cement. The finer grinding increases the cost about 6 per cent; i. e., if the coarser cement costs \$1 at the mill, then the finer cement

will cost \$1.06. We have then the following comparison:

1 1/4 bbls. 75 per cent cement \$1.25
1 bbl. 90 per cent cement 1.06

Value of superior fineness per bbl. \$0.19

As Mr. Meade says, it is not difficult on this showing to make out a strong case in favor of fine grinding. The problem is not solved, however, until the engineer takes advantage of this economy. To do this he must change his mortar proportions from 1-2 and 1-3 to 1-4. We doubt if much economy will be shown in doing this. American engineers show as a rule little interest in figuring proportions very closely to the character of the work to be done. In European concrete structures it is not uncommon to see the composition of the concrete in, say, an arch bridge, range from 1 to 12 in the footings to 1 to 4 in the arch ring. Such attempts at economy in material are rarely seen in America; it is far more common to see a 1-2-1 mixture used throughout and very few engineers reduce the composition of the concrete in the abutments to a poorer mixture than 1-3-5.

The point that we wish to make here is simply that if cement manufacturers are to be required to do fine grinding and if building owners are to be asked to pay more for especially fine ground cement, then the engineer should do his part and see that the possible economy of using the finer material is taken advantage of. The opportunities for economy in cement which lie in finer grinding, more accurate proportioning and more perfect mixing are not yet realized by most engineers. Until they are, there seems to be no urgent commercial call for finer grinding, and when they are realized we have to solve the further problem of where lies the dividing line of economy between less cement and more perfect proportioning, etc., and more cement and less perfect proportioning, etc.

The U. S. Civil Service Commission, Washington, D. C., will receive applications until Oct. 19 for consideration in connection with filling vacancies in the following named engineering positions in the Philippine Service: Eight civil engineers with high-grade experience in highway or railway location and construction, or both; salaries, \$2,000 to \$2,500 a year, according to qualifications. Five civil engineers with good experience in irrigation or reclamation engineering; salaries, not over \$2,000 a year.

George Otis Smith, Director U. S. Geological Survey, according to press reports, has invited leading railroad officers to attend a conference to consider means of preventing damage from floods. It is proposed to gather facts concerning the flow of water in streams at different times of the year and to make authentic records of the height, duration and frequency of floods.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

The Commercial Value of Fine Grinding of Portland Cement.*

BY RICHARD K. MEADE,†

The effect of the fineness to which Portland cement clinker is ground upon the physical properties of the resulting cement is well understood, and it is not the purpose of this paper to deal in generalities along this line but rather to present the results of some carefully made experiments to determine the actual commercial value of fine grinding. The two properties of cement most affected by the fineness of the product are the setting time and the sand-carrying capacity. All the properties of the cement are of course influenced to some degree. For instance, the color of clinker itself is practically black. As the clinker is ground the color becomes lighter, until at a fineness of 75 per cent passing the No. 200 test sieve, the color of the commercial product, a light buff, is reached. Cement ground so fine that 95 or 100 per cent of it will pass the No. 200 test sieve is of a somewhat lighter shade than cement ground to the ordinary fineness of 75 per cent. through this sieve. At the same time, no manufacturer would care to go to the increased expense of grinding the cement to such an extreme degree of fineness merely for the sake of a slightly lighter color, nor would even sidewalk and concrete block men care to pay the increased cost of such cement simply to obtain a slightly lighter shade in their products.

Fine grinding will also to some extent help the soundness of the cement. This is shown by Table I. No manufacturer, however, would expend his energies on the grinding of the hard clinker to an impalpable powder in order to secure soundness, when half this amount of energy expended upon the grinding of the raw materials would be much more sure of producing the same results.

Table I gives four instances in which soundness was helped by fine grinding, but in order to obtain these four instances many samples of unsound cement were ground, and the majority of them failed to become sound even after being ground to an impalpable powder. Fine grinding and seasoning, however, usually produced the desired results. That is, an unground cement after seasoning, say one week, failed to pass the boiling test, but the same cement ground so fine that none of it re-

mained on the No. 200 test sieve passed the test after seasoning one week. The grinding no doubt here breaks up the small pieces of clinker and allows the air to slake out the injurious component. In this connection, it may be said that if the coarse particles, i. e., those remaining on the No. 200 sieve, are separated from the cement and ground to a fineness of 75 per cent through the No. 200 sieve, the resulting product is unsound. It is also usually quick setting, due to the fact that the sulphate nearly all passes into the fine powder. If 1 per cent plaster of Paris is added to the powder, its setting time is normal but it is still unsound. If the powder is then seasoned for a few days, it becomes sound.

As we have said before, no manufacturer could afford to make a sound cement by grinding one unsound at ordinary fineness to say 100 per cent passing a No. 200 test sieve, as his competitors by grinding the much softer raw materials to a fineness of only 95 to 98 per cent through the 100 mesh sieve would be practically sure of obtaining the same results, provided the composition of the mixture and the burning of the clinker were satisfactory. At the same time, if the manufacturer found it advantageous to grind his cement to a fineness of 90 to 95 per cent through a No. 200 test sieve, he would also find that it had some beneficial effect upon the soundness also, and that this effect was most marked

TABLE I.—EFFECT OF FINE GRINDING OF CEMENT ON SOUNDNESS.

—Result of 5-hour Steam Test.—			
Cement No.	As received.	Ground to pass No. 200 sieve.	Ground to impalpable powder
1	Checked	Sound	
2	Checked	Sound	
3	Checked	Slightly checked	Sound
4	Checked	Slightly checked	Sound

where the cement had a chance to season or age as it usually does.

The influence of fineness upon the rate of set of cement is in some instances quite marked, in other instances this is much less noticeable. If any effect is produced at all, and there generally is, it is to make the cement quicker setting; in some instances, so quick setting as to be unfit for use, and often, where this is the case, additions of plaster of Paris fail to slow the set sufficiently to allow of its being used. In Table II are given a number of instances illustrating the influence of fine grinding upon setting time.

The question of the influence of fine grinding upon the set is an important one,

as upon this will depend to a large degree the ability to grind cement to the point where all of it is rendered useful, and where it contains no inert matter except that present chemically and not due to coarseness. The composition of the cement unquestionably has something to do with the effect of fine grinding. High alumina and low lime cements seem to have their setting time most affected by finer grinding. High lime, soft burned and low alumina cements do not seem to be so much affected.

Cements low in lime are often quick setting, and if a sample of cement is sieved through a No. 200 test sieve and analyses

TABLE II.—INFLUENCE OF FINE GRINDING OF THE CEMENT UPON ITS SETTING TIME.

Initial set in minutes when ground to the fineness indicated below through No. 200 sieve.					
Cement No.	75%	80%	85%	90%	95% 100%
1	255	246	192	75	12 2
2	105	106	100	100	22 6
3	120	115	100	95	60 35
4	240	200	180	115	60 30
5	240	210	110	55	15 5
6	200	190	175	100	25 2
7	100	100	90	80	25 5
8	115	105	100	75	30 10

are made of both the coarse residue and the fine portion passing, the former will in most cases be found lower in lime than the latter. It is natural that the softer portions of the clinker should constitute the greater part of the impalpable powder in ordinary Portland cement. When the cement is ground still finer the harder portions also are broken up, and these harder portions are probably responsible for the "quick set" of finely ground cement, owing to the fact that they are lower in lime and are burned to a high degree of vitrification. It is certainly possible, even probable, that if it is found advantageous to grind cement to a much greater degree of fineness than is now practiced, it will also be found necessary to grind the raw materials to a high degree of fineness also, in order to allow making very highly basic cement, in which the highest possible amount of lime is obtained in solution in the magma of clinker. If it is desirable to get rid of all the physically inert material by fine grinding of the clinker, it is also equally desirable to have in the cement all of the chemically active elements possible.

I am strongly inclined to believe that it will be possible to grind cement very fine without influencing the set unfavorably, by properly adjusting the composition of the clinker and the degree of burning. If the finer particles of cement, not merely the particles which pass a No. 200 sieve, but the impalpable dust, are separated from the cement, it will usually be found that this very fine material sets normally, showing that it is possible to grind some part of the cement at least to an impalpable powder. It also is now generally agreed that it is this fine powder which is the active constituent in cement. Hence it follows

*A paper read before the American Society for Testing Materials.
†Nazareth, Pa.

that the active portion of cement is not quick-setting even when finely ground, and that there is some undesirable element in the coarser and at present inert particles of the cement which is liberated or rendered active by the grinding. The problem will, therefore, undoubtedly be to keep out the undesirable element from the clinker and to increase the desirable one. I have no doubt that by the time grinding machinery has been perfected which will reduce cement to the fineness of 100 per cent through a No. 200 test sieve on a commercial basis, the chemical side of the question will have also been solved. Indeed, experiments made by the writer indicated a solution of the problem. Under present conditions it would be practically impossible to produce commercially a cement much finer than 90 per cent through a No. 200 sieve, if indeed it would be possible to reach even this fineness, and at this nothing more than a slight quickening of the setting time of properly proportioned cements should be met with.

A number of experiments were made by the writer to determine the effect of finer grinding upon the tensile strength of Portland cement. All of these experiments proved the following general facts:

- (1) That the neat strength is lowered by finer grinding.
- (2) That the sand strength is increased by finer grinding.

These two facts are shown by every series of tests made by the writer. Table III gives the results obtained in one of the most carefully made of these tests. Each figure in this table is the average of five closely agreeing breaks and all briquettes and breaks were by an experienced tester. All five samples are from the same lot of cement. In fact, a bag of cement was selected and divided into five parts and each of these ground to a different degree of fineness as shown below:

Fineness passing No. 200 sieve.	Fineness passing No. 200 sieve.
80 per cent	93.9 per cent
85 per cent	95.8 per cent
90 per cent	97.4 per cent
95 per cent	99.0 per cent
100 per cent	100.0 per cent

Referring to Table III we see a number of interesting things. The neat strength is decreased by fine grinding. This decrease is as follows: Grinding to 85 per cent fine decreases the 7-day neat tensile strength 17 per cent and the 28-day neat tensile strength 11 per cent from the figures of the 80 per cent fine. Grinding to 90 per cent fine decreases 21 and 20 per cent respectively for the same periods. Grinding to 95 per cent fine decreases 34 and 35 per cent and grinding to 100 per cent fine decreases 42 and 38 per cent. In general, it will be seen that the decrease in neat strength due to fine grinding is about the same for both the 7-day and the 28-day periods.

Referring to the sand tests it will be seen at a glance that the increase in sand strength due to finer grinding is large. Increasing the fineness from 80 to 85 per

cent increases the 7 day 1:3 sand strength 21 per cent, further grinding to 90 per cent increases it to 45 per cent, and to 95 per cent increases it to 51 per cent, while to 100 per cent increases to 63 per cent

TABLE III.—STRENGTH OF SAME CEMENT
GROUND TO VARYING DEGREES OF FINE-
NESS.

Age in days.	Neat and Sand.	Fineness through No. 200 sieve—	80%	85%	90%	95%	100%
1	Neat	369	241	308	282	200	
7	Neat	955	796	719	627	558	
28	Neat	963	849	775	626	594	
7	1/3 Sand	235	281	351	363	382	
28	1/3 Sand	297	353	468	498	576	
7	1/2 Sand	169	204	234	211	263	
28	1/2 Sand	221	266	324	377	392	

over the 80 per cent strength. The 1:1 sand strength is increased practically the same percentage. The increase upon the 28-day sand tests due to finer grinding are even larger. In this series of tests the original cement gained but little neat strength between the 7 and 28-day periods. In the case of cements showing good gain between these two periods, fine grinding will decrease not only the neat strength but also the percentage of gain between these two periods as well. An example of this is given in Table IV. In this experiment a lot of cement just as received from the mills was divided into two parts one of which was tested just as it was and the other was ground to all pass a No. 200 sieve, and then tested. Table IV gives the results obtained on the two samples.

The question naturally arises as to the commercial value of fine grinding. In other words, "is the game worth the candle?" Will the benefit to be derived from a much finer product than is at present on the market be sufficient to warrant the increased cost of its production? No very settled figures are obtainable as to the relative cost of grinding to different degrees of fineness. In an experiment made by the writer with a small tube mill in which the charge was put and allowed to remain until the desired fineness was obtained, the time required for grinding the material from the ball mill was as follows:

Fineness through No. 200 sieve.	Hours required to grind to this fineness.
75	19
80	21
85	23 1/4
90	26

On the basis of this test, increasing the fineness from 75 to 90 per cent through a No. 200 sieve would only increase the cost of grinding 37 per cent. As the cost of grinding the clinker is never more than 15 to 20 per cent of the cost of making a barrel of cement, the increased cost of grinding 90 per cent through a No. 200 sieve over 75 per cent would be only 5.5 to 7.4 per cent of the mill cost, and of course much less than this percentage of the cost of cement delivered on the work.

Referring to Table III we see that cement ground 90 per cent through a No. 200 sieve gives about the same strength mortar when mixed with four parts sand

that ordinary cement (80 per cent) does mixed with three parts sand. Hence only 75 per cent as much of the fine cement is needed as is required of the ordinary cement. Hence we reduce the amount of cement 25 per cent and only increase its cost say 6 per cent. Or at a mill cost of \$1 per barrel for ordinary cement, the finer product would be increased to \$1.06 and the cost delivered say increased from \$1.50 to \$1.56. One hundred barrels of ordinary cement would then cost \$150 and 75 barrels of the finer product, which would do the same work, would cost only \$116.

At this rate it is not hard to make out a strong commercial argument in favor of fine grinding. I am not sure, however, that the present style of continuous feed and discharge tube mills are capable of reducing clinker to such extreme fineness as 90 per cent through a No. 200 sieve with an expenditure of only 25 per cent additional energy. Tests seem to indicate that much more than this is actually required and that the output of the mill would be at least cut in half. Even at this figure the fine cement would be of commercial advantage, as the fine cement would increase the cost of grinding the clinker 100 per cent, or would make the mill cost of fine cement say \$1.20 against \$1 for the ordinary, and the cost delivered say \$1.70 against \$1.50. One hundred barrels of ordinary cement would then cost \$150 and 75 barrels of the very fine cement \$127.50.

In this connection some figures obtained with the Fuller Lehigh mill are interesting

TABLE IV.—PROGRESSIVE CHANGE IN CEMENT
AS RECEIVED AND GROUND TO PASS A
200 SIEVE.

Age	Neat As rec'd. Ground.	Sand As rec'd. Ground.
1 day ...	327	210
7 days ...	630	525
28 days ...	725	540
3 months...	730	540
6 months...	760	560
1 year ...	825	575
2 years ...	850	560

as actual results with a commercial mill on clinker. In tests, this mill pulverized clinker that had passed through a 1/4-in mesh at the rate of from 10 to 12 bbl. an hour to a fineness of 90 per cent through a No. 200 sieve, utilizing in so doing 75 h. p.-hr. A test of the product of this mill ground to 90 per cent gave the following tensile strength:

Age.	1:3	1:1
7 days	320	228
28 days	455	316

It was furthermore found possible by closing the lower part of the screens of this mill to grind cement so fine that all of it passed the No. 200 sieve. A test of this cement, the finest the writer has ever been able to obtain ground by a commercial mill, gave the following figures:

Age.	1:3	1:1
7 days	382	291
28 days	438	348

It will be seen that the 7-day figures agree very closely with those obtained on

cement all passing a No. 200 sieve in the experiment given in Table III. The failure to show the same strength in 28 days was no doubt due mainly to the fact that the cement was tested fresh from the mill.

Before leaving the subject of fine grinding I cannot resist the temptation to again call attention to facts which I first brought forth about five years ago, namely, that fine grinding without an increase in the amount of impalpable powder gains nothing. It would be easily possible to prepare a cement which would 90 per cent or even 100 per cent of it pass a No. 200 test sieve and yet which would in reality be of much less value than the coarsest commercial product now on the market. For example, if a sample of clinker is crushed in an iron mortar by a pestle and sieved as fast as it is ground through a 100 mesh screen, a product will be obtained 100 per cent of which will pass a 100-mesh screen. If a pat is made of this cement it will just about cohere. To go even further, if another sample is ground in a mortar and sieved after every few strokes of the pestle through a 200-mesh screen, the resulting product will all pass a 200-mesh screen and yet it will be almost worthless as a cement. When washed free from its flour with benzine it will just about hold together. In the writer's laboratory there is a Braun's gyratory muller for grinding samples, in which the grinding is done by an enclosed round pestle revolving in a semi-hemispherical mortar. In the bottom of the mortar is a hole which can be stopped by a plug. The grinding may be done in two ways, one by feeding the sample into the hopper in the cover and allowing it to work its way out at the bottom, then sieving out the fine material from the coarse, and returning the latter through the grinder and so on until all has passed the sieve. The other, by placing the plug in the bottom of the mortar and allowing the pestle to work upon the material until the latter has reached the desired fineness. Two samples of cement were prepared from the same lot of clinker by these two methods. One sample, the one made by passing the clinker through the muller and sieving out the 200-mesh particles after each grind, would of course all pass a 200-mesh sieve. The other sample, the one made by grinding the whole sample to the desired fineness without screening, tested 96 per cent through a 100 mesh sieve and 76.5 per cent through a 200-mesh sieve. Sand briquettes were made of these two lots of cement with the following results:

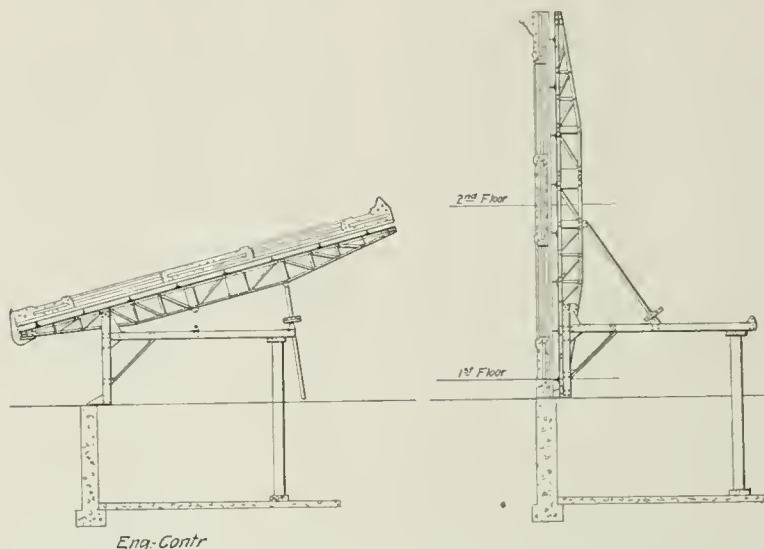
Samples made by grinding and screening to fineness (all 200 mesh)	7 days	28 days	3 mos.	6 mos.	
Grinding to fineness without screening	215	295	325	318 lbs.	
	Chips.	Chips.	Chips.	28 lbs.	

The cementing value of Portland cement depends upon the percentage of those infinitesimal particles which we call flour. No sieve is fine enough to tell the quantity

of these present. At the same mill it is probable that the sieve test is relative, but to the engineer who is called upon to examine the product of many mills using different systems of grinding the sieve test is hardly to be expected to give relative percentage of flour in each. The products of the Fuller-Lehigh, the Griffin mill and of the ball and tube mill differ much in the percentage of flour present, although testing the same degree of fineness on the 200-mesh sieve. Even with the ball and tube mill system, one ball mill and two tube mills would probably give a product

Wall Construction of Separately Molded Reinforced Concrete Panels.

Recently a number of buildings have been constructed by molding the wall flat in one or two-story sections up to 100 ft. long and tilting the molded slab or panel onto edge by means of special jacks. The accompanying sketches show the jack construction. These apparatus are spaced 8 ft. apart and carry the forms in which the wall is molded complete with window frames and other attachments in place. Simultaneous operation of the jacks tilts



Sketch Showing Construction of Jacks Used in Raising Wall Slabs.

with a higher percentage of flour than one tube mill and two ball mills, although the cement was ground to the same sieve test. The size screen on the ball mills probably also influences the percentage of flour in a product of a certain fineness.

Surveys are now underway on an irrigation project which contemplate the reclamation of about 700,000 acres of arid land in the southern Idaho. The project is practically an extension of the noted Twin Falls development. Water supply for the proposed extension will be obtained from Snake River. The lands lie to the west of the Twin Falls tract beyond Salmon River and in part beyond Bruneau River. The surveys in progress include reservoir sites, the enlargement of the present Twin Falls canal, which has been developed to a capacity sufficient to carry the increased water supply, an extension of the main canals to cover the lands of the project including a syphon to carry the water supply across Salmon River Canyon, which is about 1,650 feet wide and whose bed is 500 feet below the level of the proposed canal. Five surveying parties are already in the field at work on the various parts of the project. J. G. White & Co., Inc., New York, are the engineers in charge for Mr. F. H. Buhl, of Sharon, Pa.

the section of wall into place as shown by the illustration.

This method of wall construction has been used for a number of buildings, mostly small, in the vicinity of Chicago, Ill., and also for the large State National Guard mess hall at Camp Perry, O. It has proven wholly successful as far as tried. The method has been developed by Robert H. Aiken, Winthrop Harbor, Ill.

The U. S. Forest Service will soon have forestry experiment stations established in a number of Western states in which there are national forest reserves. One experiment station already has been established in the Coconino National forest, with headquarters at Flagstaff, Ariz. It is intended ultimately to have at least one experiment station in each of the silvicultural regions of the West. At each of the stations model forests typical of the region will be maintained. In the Coconino forest one of the first problems to be taken up will be the study of the reproduction of Western yellow pine, which in many cases does not form a satisfactory second growth. Light requirements of different species of trees at different altitudes, effect of forest on temperature, humidity, melting of snow, wind velocity, etc.; relative value of the germinating power of seeds, etc., are among the other studies which will be taken up soon.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Excavating Earth and Hauling in Small Steel Cars.

Small cars of various sizes and styles are being used more and more extensively by contractors. This is especially so in earth excavation. Wooden cars have been used for this purpose many years, but during the past decade the all-steel car has come into use and is growing in favor with contractors.

One reason for this is that it is light in weight for its size and is well balanced for dumping, allowing one man to dump the small car and right it. This is a great consideration in cars for earth and rock excavation. The writer has seen $1\frac{1}{2}$ cu. yd. cars that took three or four men to dump. Another advantage is that they stay on the track while being dumped, without

erated on a 30-in. gage track, and were 4 ft. 5 ins. high, and about 5 ft. 7 ins. wide. These cars weigh 1,080 lbs. Some of them were equipped with brakes. The average cost of the cars was \$90, and as 40 were used the total cost was about \$3,600. The cars were operated in trains of 4 cars, and coasted to the dump by gravity, being hauled back to the cut by one horse and a driver. Thus five horses were used for the 40 cars. The dead load pulled back by the horse was about 4,400 lbs. A 20-lb. rail was used, laid on wooden ties. In all, $2\frac{1}{4}$ miles of track was used on the job. A 20-lb. rail will carry a load of from 5 to 6 tons, this capacity referring to a load on a four-wheel car. Several turn outs and switches were used, thus allowing the cars to be kept almost continually in motion. Seventy tons of 20 lb. rails were used, and,

material was a boulder clay, consisting of loam, clay, gravel and hardpan, and while most of it required but little loosening with picks, yet some of it had to be drilled with short holes and shot with 20 per cent dynamite. Some of the work, where the banks were low, was worked from on top, but most of it was worked from abreast. Men shoveled the material with short handled shovels.

The excavated material was hauled from 700 to 1,000 ft., the average haul being about 850 ft. There were 80 men employed on the job working under 3 foremen. The wages paid for a 10-hour day were as follows:

Foreman	\$3.00
Laborers	1.80
Drivers	1.80
Horse	1.00

During the month of June in 25 working days, 15,000 cu. yds. of material were excavated. The total cost for this work was as follows:

3 foremen, 25 days.....	\$ 375.00
75 men, 25 days	3,375.00
5 drivers, 25 days	225.00
5 horses, 25 days	125.00
300 lbs. dynamite at 10 cts.....	30.00
Plant charges (estimated).....	127.00

Total\$1,257.00

This includes all the cost except general expenses, and the month's proportion for laying track. The cost per cu. yd. was:

Foreman	\$0.025
Loosening and Loading	0.225
Hauling	0.023
Explosives	0.002
Plant	0.008

Total\$0.283

The wages on this job were high, but, taking these into consideration, the cost is low, for the length of haul. The item of transportation for an 850-ft. haul is very low, as compared to car or wagon hauling, since it amounts to only $\frac{1}{4}$ ct. per cu. yd. per 100 ft. of haul. The largest item is that of loosening and loading, and with wages at \$1.50 per day this cost would be reduced nearly 4 cts. per cu. yd. The charge of a dollar per day for a horse, covers feed and care, as well as interest and depreciation.

We are indebted to Mr. J. B. Eveline, of Eveline Bros., contractors, Attleboro, Mass., for the information upon which this article is based.

During August, 1,091,891 cu. yds. of material were excavated in the New York State Barge canal. In July, 1908, the Barge canal excavation was 1,067,111 cu. yds., 99 per cent of the amount at Panama for July 1907, which was 1,076,767 cu. yds. The yardage for August, as given above, is 86 per cent of that in the Isthmus for August of last year, which was the largest attainment there up to that time—1,271,966 cu. yds.



Fig. 1—View Showing Excavation Work in Progress.

it being necessary to chain the frame to the track. With the V-shaped steel cars, the car body rocks on the car frame when it is dumped, thus making the material clear the track. The dumping angle is such that the load is discharged instantaneously. In loading the cars, they can be partially tilted until half the load is shoveled into them, thus cutting down the height of shoveling. It is also stated that with the steel the life of the car is much longer than timber cars, and the repairs are reduced to the minimum. Thus the car is seldom out of service for repairs.

In this article we will give the cost of excavating and transporting earth with this style of car at Attleboro, Mass. The cars used were $1\frac{1}{2}$ yard V-shaped, all steel cars, manufactured by the Arthur Koppel Co., New York and Pittsburg. They were op-

erated at a price of \$32 per ton, the cost was \$2,240. The ties are only split ones or roughly hewn, and spaced on about 3 ft. centers. About 4,000 ties were used. At a cost of $12\frac{1}{2}$ cts. per tie, the total cost for ties was \$500. These ties could be used on several jobs. The total cost for plant outside of small tools was:

40 cars at \$90	\$3,600
70 tons rails at \$32	2,240
4,000 ties at $12\frac{1}{2}$ cts.	500

Total\$6,340

Estimating, interest, depreciation and repairs to the outfit at 2 per cent per month, we have a monthly charge of about \$127 for plant.

Fig. 1 shows character of the material and also of the work that was done. The depth of cut averaged from 3 to 12 ft. The

The Value of Cost Keeping; a High Cost of Wheel Scraper Work and a Lesson.

One of the greatest uses of cost keeping and cost analysis is for determining the proper methods of carrying on work. If the detailed records are kept and promptly analyzed, mistakes made in carrying on construction work are discovered quickly, and by the daily or weekly checking up of the costs and tabulation, a money losing job can often be changed to a money making job. This is especially true of earth and rock excavation.

If forces are being handled without any apparent hitch, and all the men and teams are working hard, the impression is that money is being made, unless the work has been taken at absolutely ruinous prices. Such impressions are often wrong. The writer could give numerous examples from his own experience. He recalls one that illustrates the point he wishes to make exceedingly well.

A few years ago one of the editors of this journal became a partner in a contracting firm building railroads in the mountains. His partner had employed for some years a foreman for rock work, and the contractor's impression, gained from seeing this foreman at work, was that he was one of the most competent foremen he had ever employed. However, he had never kept the detailed cost of his work, nor kept a record of the cost of each foreman's work. As soon as the writer became a partner of the firm, he had this done. Each month a record was kept of every detail of the work and every foreman was charged with all labor, teams, explosives, supplies, etc., that he used, and he was credited with the materials he excavated at the contract prices. The foreman in question was working in a cut, where the contract price was about 15 per cent higher than the contract price paid for solid rock, although the material in the cut was unclassified. In spite of this, every month's record and analization of the costs showed that this foreman was losing money, while other foremen, with a classification to contend with and lower prices were making money. The writer pointed out these facts to his partner, but the impression that the foreman was a competent one was so deeply rooted that excuses were made for him when none existed. If cost records had been kept on this foreman from the day he was first employed, his true value would have been shown.

This incident shows the value of cost keeping in selecting and employing men. Another one illustrates the value of cost keeping and analysis in handling details of the work. The same editor was excavating some cellars, and following his rule, he kept the cost of each item of the work. The picking and loosening of the earth was kept separate from the shoveling. Each night the amount of work done during the day was measured up and the

cost records of the day analyzed. The details of the cost were figured out in cents and mills. One day's records showed that the cost of picking had increased over the past four or five previous days, some 5 or 6 mills. Close questioning of the foreman revealed the facts that the material was about the same and the method of attack was similar, thus showing no plausible reason for this slight increase. The foreman was accordingly ordered to put one of his pickers to shoveling the next day. This was done with the result that the cost of picking dropped back to normal; 14 additional cu. yds. went out of the cut thus securing an increased payment with the same pay roll. This reduced the unit cost of hauling, dumping and superintendence. Without daily cost keeping and analysis this could not have been done.

The record of cost of making a railroad cut with wheel scrapers, given below, is hardly of value as the cost of scraper work, but it demonstrates by an actual example of cost, how a lesson can be learned from cost keeping.

The material in the cut was a red clay with springs of water occurring in it. This, with the fact that the clay quickly absorbed the rain water and held it, made the cut a wet one. Wheeled scrapers were used and a three-horse snatch team for loading them. A four-horse plow team loosened the dirt. The following wages were paid for a 20-hour day:

Foreman	\$3.00
Scraper team and driver	4.75
4-horse ploy team and 2 men.....	9.20
3-horse snatch team and 1 man.....	6.00
Loaders	1.60
Dumpmen	1.50
Water boy	1.00

Two men loaded the No. 2½ scrapers, and one man dumped them. The lead was 700 ft., while the total distance traveled to and from the dump averaged 1,650 ft.

The cost of the work per cu. yd. was as follows:

Foreman	\$0.063
Scrapers	0.500
Plowing	0.200
Snatching	0.127
Loading	0.067
Dumping	0.032
Water boy	0.021

Total

The average number of cu. yds. moved per day per scraper was 9.5, and as 10 scrapers were used on the haul, the outfit moved a total yardage per day of 95 cu. yds. This gives the amount loosened by the plow. The average number of yards moved per team worked in a day was only 5.5. Each scraper team traveled about 9 miles per day.

In ENGINEERING-CONTRACTING for July 8, 1908, p. 33, nine examples of the cost of excavating earth with wheel scrapers were given. The wages paid were the same as in this case. Example No. 5, was for a 700 ft. lead. The total cost was about 36

cts. Seven scrapers were used in the gang and 161 cu. yds. were moved in a day by the 7 scrapers, making 23 cu. yds. per scraper day and 15.5 cu. yds. moved per team worked, per day. Each scraper team traveled about 19 miles per day.

A comparison of these two examples shows at once the great cost of the first example, a cost that would be ruinous to any contractor if the amount of material to be moved was large. The reason of the high cost is very evident. The scraper team in one case traveled 19 miles, in the other only 9 miles. This was caused by the wet condition of the cut, and ten scrapers each going through it 28 or 29 times a day meant cutting up the wet clay still more. These conditions and such a cost clearly show that another method of excavating the earth should have been used, but unless cost data were kept on the work, this high cost would not have been as evident until considerable money had been lost.

The method to consider to substitute for the scrapers should be one that would reduce the hauling through the cut. This would be the substitution of small cars and track for the scrapers. Even with small wooden cars, say of 1½ cu. yd. capacity, one horse could pull, on fair grades, 2 cars to the dump, and it would mean that only one animal's tracks would be made in the wet clay for about 2 cu. yds. place measurement, instead of the tracks for six trips of a two horse team and a pair of wheels. With all steel cars generally 4 cars are operated in a train, pulled by one horse, which would make a greater reduction in the number of trips to the dump. On down grades from the cut to the dump, well huilt cars will coast with their loads, and it is only necessary to pull back the empties. The cars could have been loaded in one of two ways, either by hand, that is men with shovels, or by wheel or drag scrapers, through a trap.

The installation of the track and cars, especially if the portable track were used, could be made at a small cost, and the plant charges per day, using eight all steel cars would not be a large sum. Such an outfit would cost about \$10,000 and plant charges at two per cent per month would be less than one dollar per day. This with a cut containing 5,000 cu. yds., the cost per cu. yd. for installation and plant charges would be very small.

With men loading the cars, say 24 men working with picks and shovels, and each man only handling 7 cu. yds. per day, which is a low output, the cost of the work by this method would be less than 30 cts., which would effect a great saving, several times enough to pay for the entire outfit of cars and track.

This is not mere theory, but is based on actual experience. Many contractors do not seem to realize the efficiency of small cars for excavation work. Some years ago one of the editors of this journal, bid on some earth excavation, that was the ex-

tension of some work, that had been let to another contractor. The first contractor bid upon the new work, but the editor underbid him some cents. The old contractor, who had done his work with wheel scrapers, in a friendly way, told the editor that his new contract would be a losing one, as he had made but a small margin at his high prices. The editor though, had decided that small cars should be used on the work, and he had based his bid on an analysis of cost of doing the work in that method. He laid tracks and used cars and cleared more money at his low price than the first contractor did at his higher price.

Thus the lesson to be learned from this high cost of wheel scraper work is that the excavation should have been made with small cars and tracks.

Work has been started by J. G. White & Co., Inc., New York, on its contract for the construction of a complete irrigation system for the Idaho Irrigation Co., Ltd., which will reclaim about 150,000 acres of land in southern Idaho. The water supply for this project will be obtained from Big Wood and Little Wood rivers. The lands to be irrigated are in the vicinity of Shoshone, Richfield and Gooding. The irrigation system will consist of a storage dam, four diversion dams, four main channels, each leading to one of the tracts of land into which the project is divided and the complete system of distribution and drainage ditches necessary for the irrigation of these lands. The storage dam, which will form a reservoir of more than 150,000 acre feet capacity, is to be built in the channel of Big Wood River in a lava canyon and is to be about 115 ft. high, of rock fill type with concrete core. The diversion dams, two of which will be in the channel of Big Wood River and two in the channel of Little Wood River, are relatively small structures of sufficient height to raise the water to the level of the canals. The aggregate length of the main canals will be more than 75 miles, varying in capacity in proportion to the areas of the tracts to be irrigated. The largest canal will have a capacity of about 760 second feet. Distributing canals and ditches will be built over the entire area to reach every quarter section of land. The above work will cost approximately \$3,000,000.

No bids were received Sept. 9 by the State Superintendent of Public Works, at Albany, N. Y., for work under contract No. 20, Erie canal. The contract called for dredging a channel in the Mohawk River and work incidental thereto, and the estimated cost was \$4,173,900.

Austria-Hungary will probably spend about \$15,000,000 in the renewal of rolling stock for the railways, recently acquired by the state.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

A New Form of Gang Saw for Quarry Work.

A practical and economic improvement in gang saw construction has been worked out at the mills of the Indiana-Bedford Stone Co., and is described as follows in the annual report of the State Geologist of Indiana for 1907:

John M. Owens, superintendent of this company, has perfected an ingenious wire saw gang to replace the cumbersome and slow gang saws used in all mills at the present time. To a certain extent the idea is taken from both the gang saw and the early wire saws of one running wire. The new saw consists of a number of endless twisted strands of wire running in a triangle over three shives. The whole apparatus is placed in a stall similar to that of the old gang saw, and hence the latter can readily be replaced. The new wires are made of $\frac{3}{4}$ -in. strands of twisted wire in endless chain and welded by electricity. In the old wire saws, the wires were spliced between strands and so permitted of slack, which had to be continually taken up by an attached piece of machinery. The joint thus welded by electricity is free from cracks and eliminates all slack and any device for taking up the same. The welding was suggested by the American Steel Wire Co., and is done by a small machine connected to the electric power of the company. The wire travels at the rate of 1,100 ft. per second, and in making the circuit once it twists four times in one foot, or 186 times in one revolution. Any number of wires can be used, depending on the width of the slabs of stone to be cut. In case of the old wire saw only one wire is used. The frames at each end of the stall holding the shives have places for any number desired. As the wire passes over the stone the feed is downward, and from an overhead trough, as in the old gangs, there is fed through small pipes and hose the necessary amount of clear water and sand to aid in cutting. The sand and water trough is circular and made of sheet iron. It is placed in the rear of the stall. The sand settles in the openings, and the water in draining off regulates the feed of sand. In the case of the old gangs a constant flow of water was used and the sand had to be fed by hand. The sand falls into the twists of the wire and is thus kept from being crushed and so losing its grit power and cutting efficiency, as happens with the old saw gang. With the use of this sand the wires attain a sharp edge and, until absolutely smooth, are effective in their work. As the water is fed in the rear the wires draw it with the sand to the front, where it splashes or falls against a

shield called the splash board. Thus the sand is caught and utilized again. The hubs in the revolving shafts last permanently and are shifted with a nut key, but the rims which hold the wires last about a year and cost \$1.25. They are of cast iron and are easily replaced by being screwed to the shaft on a square key, thus eliminating sliding.

In the case of the old gang saw the motion is a lift back and forth of blades $\frac{3}{8}$ -in. thick. The sand in the cut grooves gives it a tendency to shift over, leaving uneven faces which have to be planed over. In the new gang the wire cuts down evenly, consistently and three times as fast, so that the planing to be done is light. There can be but little shift, if any, owing to the speed of the wires.

Since the old wire saw is hand fed it cuts but about 5 ins. per hour and lasts only 30 hours before it has to be replaced. They are 50 ft. long, and split the block once with a double length running straight overhead. In the new device the wires are $16\frac{1}{2}$ ft. in length and cut 18 ins. per hour. The cost is 90 cts. per 100 ft. The wires give two faces on a block of 116 superficial square feet.

In the new gang the cumbersome shafts of the old gang are done away with and all the additional machinery to run the saw, drive and fit the blades, keep up the pump for continual supply of water is unnecessary. One man can operate the new saw, whereas two men are required with the old. If a new wire is to be replaced from a stock at the side of the shives, it is slipped over the rim with but little exertion. Compared with the old method, time and labor are saved, neater work is done, the cost of running less, and, as a whole, the apparatus is far cheaper. The cost of a new machine is \$600, whereas old gangs cost about \$1,000. Such an improvement as this is adding efficiency and increase of output to the polioitic stone industry.

A new type of locomotive has been introduced on Russian railroads. It is the so-called improved 4 and 5 axle type of the Southeastern railroads. The 5-axle locomotive weighs 154,728 lbs., and the 4-axle tender 13,101 lbs., total weight 167,829 lbs. The cost of this locomotive is, according to the estimates of the factories, \$26,350. It is the most expensive of all types of locomotives used in Russia.

Up to Sept 1, 27 contracts had been awarded for work in the New York State Barge canal. The contracts cover 153.49 miles of canal.

Methods and Costs; Some Old; Some New.

Testing Character of Soil by Sounding.

The following arrangements was used in making soundings to determine the character of the soil at the site of a reservoir. The arrangement consisted of an iron rod 1 in. in diameter and 30 ft. long, on which was arranged a sliding weight. This weight was made of a short section of 6 in. cast iron water pipe, in the center of which was a 1 1/4 in. wrought iron pipe, the space between the two pipes being filled with lead. The upper part of the rod was steadied by a tripod. On the bottom was an iron pipe, the whole weighing about 130 lbs. The weight was lifted by two men and allowed to fall on an adjustable clamp. The height to which it was lifted varied from 3 to 1 ft., and a record was taken of the depth penetrated by each ten blows. A block and fall was used to withdraw the rod.

Filling in Marshland.—A tract of marginal marshland was raised well above the effects of tide water in a lake in the following manner. The marshland was underlaid by plastic blue mud, resting upon a solid bed of yellow clay hard pan. The latter had a natural slope of about 13 degrees toward the lake. At the high water line the mud was about 40 ft. deep. A further complication was the proximity of a deep water channel and a system of tidal sluice-gates in front of and parallel to the shore line. No encroachment could be made on this channel by pushing out the marsh mud under the pressure of the new filling. The first thing done was to dig a trench 4 ft. deep by 12 ft. wide along the water edge of the marshland. The excavated material was deposited on the edge of the trench next to the highland, the top width of the bank being of sufficient width for two runways for wheelbarrows. Heavy, sandy material was then used for filling at and along the segregation line, advancing gradually toward the lake. As filling progressed, settlement commenced and the material in the bottom of the trench began to rise up. A large force of laborers were kept busy excavating and removing the material from the rising bottom as fast as it came up. This process was continued until the entire marshland was filled in solid down to hard pan and all settlement had stopped. An interesting part in connection with the work is that the total yardage taken out from the bottom of the trench was approximately the same as the total yardage of heavy material in the filling in below the level of the marshland, and yet after the completion of operations, the dimensions of the trench were the same as at the beginning. It seems probable, therefore, that the trench simply afforded a natural vent for the escape of mud, compressed by

the weight of the advancing filling deposited on the marshland.

Hours and Wages of Common Labor in 1907.—The following table, which is taken from a recent bulletin of the U. S. Bureau of Labor, shows the average number of hours worked per week and the average wages per hour for common labor on contract work in street and street sewer construction in 1907:

Locality.	Average hours per week.	Average wages per hour.
Albany, N. Y.	52.77	\$0.1963
Atlanta, Ga.	60.00	.1500
Baltimore, Md.	50.43	.1909
Boston, Mass.	59.31	.2021
Buffalo, N. Y.	51.13	.2284
Charleston, S. C.	60.00	.1097
Chicago, Ill.	53.89	.2542
Cincinnati, O.	58.53	.2023
Cleveland, O.	60.00	.1901
Dallas, Tex.	51.62	.2064
Denver, Colo.	54.00	.2661
Des Moines, Ia.	54.00	.2276
Detroit, Mich.	60.00	.1879
Dubuque, Ia.	59.55	.2039
Duluth, Minn.	60.00	.2317
Grand Rapids, Mich.	60.00	.1905
Indianapolis, Ind.	58.00	.2210
Jacksonville, Fla.	60.00	.1546
Jersey City, N. J.	59.00	.2063
Kansas City, Mo.	58.72	.1977
Los Angeles, Cal.	60.00	.2115
Louisville, Ky.	59.52	.1790
Lynn, Mass.	54.00	.1906
Memphis, Tenn.	54.81	.1765
Milwaukee, Wis.	60.00	.2284
Montgomery, Ala.	60.00	.1312
New Haven, Conn.	60.00	.1659
New Orleans, La.	59.09	.1907
New York, N. Y.	58.47	.1753
Norfolk, Va.	60.00	.1438
Peoria, Ill.	60.00	.1844
Philadelphia, Pa.	60.00	.1547
Pittsburg, Pa.	60.00	.1723
Portland, Ore.	60.00	.2500
Providence, R. I.	59.44	.1921
Racine, Wis.	59.58	.2113
Richmond, Va.	59.22	.1534
Rochester, N. Y.	48.00	.2177
St. Louis, Mo.	59.33	.2243
Salt Lake City, Utah.	48.00	.2554
San Francisco, Cal.	48.00	.3125
Scranton, Pa.	51.94	.1752
Seattle, Wash.	48.00	.3090
Sioux Falls, S. D.	60.00	.2500
Syracuse, N. Y.	59.66	.1936
Tacoma, Wash.	49.83	.2967
Terre Haute, Ind.	54.00	.1949
Toledo, O.	51.51	.2362
Trenton, N. J.	60.00	.1500
Washington, D. C.	52.37	.1829
Wheeling, W. Va.	54.00	.1944
Wilmington, Del.	57.00	.1564
Worcester, Mass.	48.75	.2192

Specification for Coal Tar Creosote.—Messrs. Herman Von Schrenk, E. B. Fuls, and A. L. Kammerer in a paper published in a bulletin of the American Railway

Engineering and Maintenance of Way Association recommend the following as a standard specification for coal-tar creosote: The oil used shall be the best obtainable grade of coal-tar creosote; that is, it must be a pure product of coal-tar distillation and must be free from admixture of oils, other tars or substances foreign to pure coal-tar; it must be completely liquid at 38 degrees Centigrade, and must be free from suspended matter; the specific gravity of the oil is at 38 degrees Centigrade must be at least 1.03. When distilled according to the standard method, that is, using an eight ounce retort, asbestos covered, with standard thermometer, bulb 1/2 in. above the surface of the oil, the creosote, calculated on the basis of the dry oil, shall give no distillate below 200 degrees Centigrade, not more than 5 per cent below 210 degrees Centigrade, not more than 25 per cent below 235 degrees Centigrade, and the residue above 355 degrees Centigrade, if it exceeds 5 per cent in quantity, must be soft. The oil shall not contain more than 3 per cent water.

Packing Earth Roads.—The Illinois Highway Commission in 1907 tried an interesting experiment in earth road building. The back rolls of a heavy roller were fitted with heavy spuds about 6 in. long. The earth from the center of the road was thrown to each side with a grader and then packed back in layers. The rolling was continued until the spuds would not sink into the surface. In this manner as thick a layer of packed earth was built up in a short time as would take several seasons of constant dragging to form. The cost of packing roads in this manner is estimated at about \$300 per mile.

The ties ordinarily used on the Federal railways of Switzerland are: Iron ties, about 8 ft. 10 ins., weighing 150 lbs., manufactured in Germany, and costing \$2.13 delivered at Basel; oak ties, same length, 6 ins. high and 10 ins. wide, made in France and Switzerland, and costing \$1.80; beech ties, same dimensions, made in Switzerland, and costing \$1.61; and fir ties, same dimensions, made in Switzerland, and costing \$1.26. The wooden ties are all impregnated with tar oil. On the secondary roads similar ties are used, but about 10 ins. shorter, the cost being relatively smaller.

The Mexican Central Ry. will probably plant 12,000 to 15,000 eucalyptus trees shortly as an experiment. If it is found that the planting is a success in the different climates and soils of Mexico, the company will put in a large acreage.

The Cuban Department of Public Works has entered into a contract with Hugh J. Reilly for the construction of a water-works and sewerage system in the city of Cienfuegos. The total cost is not to exceed \$3,080,000.

The Method of Sinking the Piers for the Grand Trunk Pacific Bridge at Fort William, Ontario, Can.*

By H. L. WILEY, JUN. AM. SOC. C. E.

This paper outlines the construction methods used in sinking the piers for the Grand Trunk Pacific Railway Bridge, crossing the Kaministiquia River, at Fort William, Ontario, Canada.

The proposed terminals of the Grand Trunk Pacific at the head of Lake Superior are separated from the main line by the Kaministiquia River. At the bridge site the river has a maximum depth of about 20 ft. at low water, being at that stage 325 ft. in width. The north bank of the river, to which the draw span of the bridge swings, is steep, and rises to a height of about 35 ft. above water. The south bank is low, sloping from the river at a grade of 1:10.

Test borings taken at the bridge site during the winter of 1906-7 by the railway engineers showed a stratum of firm blue clay, about 35 ft. thick, covering a layer of water-bearing gravel varying in thickness from 3 to 7 ft. The water contained in this gravel was under sufficient pressure

and rendering all outside work more costly. Therefore operations were begun immediately.

For the falsework at the pivot pier, two rings of piling were driven about the center of the pier, the diameter of the inner ring being 37 ft., and of the outer one 54 ft. These piles were cut off and capped 8 ft. above the water. The caps were of 12 by 12-in. fir timber, radial from the center of the pier, and overhanging the perimeter of the steel shell 2 ft. There were twenty piles in each ring. These were crossbraced and tied securely, making the structure as rigid as possible, to lessen any movement that might be caused by the current, which varied from 3 to 6 miles per hour. The piles were driven to gravel, to prevent settlement in the finished falsework. The structure was then decked and a circular track built upon it. This track was for a small derrick car, the purpose of which was to pick up the plates forming the shell, carry them to place, and hold them in position while being bolted up ready for riveting.

A slot, 2x8 in. was cut through the caps where their center lines intersected the perimeter of the steel shell, and a casting,

up ready for riveting, averaged about 2½ hours, or 15 min. for each plate. Five courses were riveted up when the shell touched bottom. The weight of the shell caused it to penetrate the bottom to an average depth of 1 ft. A 2-ft. water jet was then rigged from a single cylinder, 6-in. steam force pump, and by this means the material at the cutting edge was disturbed sufficiently to permit a further settlement amounting to about 1 ft.

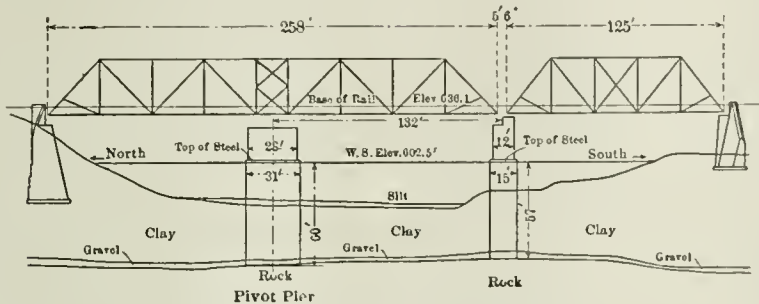
Each outside hanger rod was then carried back to the pile carrying the cap from which the rod was suspended, and bolted to the pile, thus tying the inner end of the cap in place. Jacks were placed under each cap, resting on the edge of the shell, and the combined action of the water-jet and twenty jacks forced the shell about 5 ft. farther into the bottom, the total penetration being at this time 7 ft.

The shell was then pumped out. As the water was removed, a course of bracing was placed at each horizontal seam of the shell. This bracing was of 12x12-in. hemlock, four timbers being set in the form of a square. Two squares were placed together, one being turned 45 degrees about the center of the pier, thus forming a star-shaped set of bracing, giving eight points of support to the sides of the shell, and leaving an octagonal central opening about 18 ft. across.

Five days after the shell was cleared of water, the material under the cutting edge gave way, and the shell filled, the blow being confined to about 4 ft. of the perimeter. The hole was carefully filled, and the shell pumped out again, only to blow out, about 5 hours later, at a different point.

At this time a flow of water within the shell was noticed, coming apparently from one of the holes left by the test borings, and being approximately equivalent to the flow from a 4-in. pipe. It was evident that there would be great difficulty in keeping the shell cleared of water, and an attempt was made to sink it still farther into the river bed. It was loaded with 175 tons of steel rails, the jacks were placed in position as before, and it was forced downward another 5 ft., the total penetration then being 12 ft. Another attempt to clear the shell of water, resulting in failure, indicated that the flow from the gravel had destroyed the integrity of the material within the shell. This method was abandoned and the work proceeded as follows:

The overhanging caps were cut off, and two more courses of steel were riveted up. Timbers were placed across the top of the shell, and a tight floor, about 1 ft. from water level, was hung from these timbers, within the shell. A form was built, following the octagonal outline of the inner opening left by the timber bracing, and concrete was deposited between this form and the steel shell. Meanwhile, a derrick was erected on a fender crib which had been sunk immediately up stream from the pivot pier, and excavation



Sketch Showing General Plan of Work.

to maintain a steady flow through several of the abandoned test holes, and, when confined, it rose to an elevation 4 or 5 ft. above the river level. This gravel is underlaid with bed-rock, from 57 to 60 ft. below the water surface. The rock surface is comparatively level, dipping to the north about 2 degrees.

The plans prepared by the railway showed only the general design of the two piers, the details and construction methods being left for field decision. The pivot pier consists of a steel shell, 31 ft. in diameter, sunk to bed-rock and filled with concrete. The south pier is composed of two smaller shells, set side by side. These are 15 ft. in diameter, and 18 ft. apart from center to center.

The plans called for ½-in. plate, single-riveted on the horizontal seams, and double-riveted on the vertical seams, and ¾-in. rivets with round heads. The contract for the work having been let in the latter part of August, 1907, an interval of about 3 months remained before severe cold weather would set in, closing navigation

through which "hanger rods" worked, was set on each cap. The hanger rods were for holding a course of plates during riveting, supporting the finished shell until the river bottom was reached, and for controlling the movements of the shell until it rested on bed-rock. The rods were 8 ft. long, of 1½-in. steel, threaded, and an eye of Swede iron was welded to the lower end of each. Hook-plates, hung in these eyes, connected the hanger rods and the plates forming the shell. There were two hanger rods at each cap, 4 in. from center to center, one outside of the shell, and one within it. The hook-plates covered four rivet holes, and were bolted to the steel plates while the derrick car held them suspended, the weight of the plates being transferred to the hanger rods by slacking the chain blocks with which the derrick car was rigged.

The plates were of ½-in. steel, 10 ft. long and 5 ft. wide; they were curved to a radius of 15½ ft., and weighed about 1,100 lb. each. There were 130 plates in the shell; 13 vertical courses of 10 plates each. The time required to swing the plates for one course from the storage yard to the derrick car, and to bolt them

*Reprinted from the Proceedings of Am. Soc. C. E., vol. xxxiv, p. 558. Read before the society Sept. 16, 1908.

was commenced within the shell, using an orange-peel bucket. The settlement of the shell was constant from this point, and, as it sank, the ring of concrete was carried upward, thus forming a steel-protected pipe or drum, having an outside diameter of 31 ft., the inner opening being octagonal.

When the shell finally reached rock, the surface of the rock was cleaned, and a layer of concrete about 7 ft. in thickness was deposited under water, which sealed the flow from the water-bearing gravel and allowed the removal of the bracing. When the timber was removed, the interior opening was filled with concrete, forms were built at the water level, and the pier was carried up to its final elevation.

The concrete used was a 1 : 3 : 5 mixture, the gravel and sand being brought in by train from a point thirty miles distant on the line of the Grand Trunk Pacific. The material was clean, and in its natural state closely approximated the required proportions. Tests were made from time to time to determine its condition, and enough sand was added to make it comply with the specifications. Screening was considered unnecessary. To prevent the concrete from freezing, the sand and gravel were heated. Three heaters, made from sections of 36-in. cast-iron pipe, were placed near the stock piles. Wood for heating purposes was plentiful, and the cost of heating all material averaged about \$1.00 per cubic yard of concrete. The materials were conveyed to the mixer by cars, and the concrete was swung to the derrick on the fender crib by using a second derrick located on the river bank. After the ice formed, the derricks exchanged boxes on the ice, and the mixer, running constantly, kept one batch of concrete moving at all times. The batches averaged 22 cu. ft., the average output being 11 cu. yd. per hour.

In the concrete, pieces of stone, containing from 2 to 15 cu. ft., were placed by the derrick on the fender crib. These stones were heated by immersing them in a tank of hot water for a few minutes, the volume being indicated by a displacement scale marked off inside the tank. In this way a check on the total volume of material was obtained, the combined volumes of stone and concrete equaling the quantity indicated from measurements made inside the shell. The total quantity of stone and concrete in this pier is 2,200 cu. yd.

Conditions at the smaller pier on the south side of the river were somewhat different, the water being only 17 ft. deep, and bed-rock 57 ft. from the water surface.

This pier consists of two concrete-filled steel shells, 15 ft. in diameter, set side by side at right angles to the center line of the bridge, with a space of 3 ft. between them. Falsework, similar to that at the pivot pier, was erected. To handle the steel plates, a derrick was placed on the

center line of the bridge, resting on three small cribs sunk for the purpose.

The shells were lined with concrete as they sank, and, owing to the fact that they could be pumped out, about two-thirds of the total excavation was completed in the dry, the derrick disposing of the material as it was excavated. The shells were in no way connected, but were carried down with as nearly the same amount of progress as possible. The general progress was in jumps of from 2 to 5 ft. The steel was carried high enough at all times to prevent any chance of the shell disappearing beneath the surface. The progress could be closely controlled by the amount of excavation. The shells were brought to place finally with a difference in elevation of less than $\frac{1}{2}$ in. Along the center line of the bridge, they were built about 4 in. out of position. This was corrected when the forms were built at the water line, where a slight offset had been provided for such a contingency.

There are 1,055 cu. yd. of concrete in this pier, the same mixture, 1 : 3 : 5, being used as in the pivot pier. The two shells were joined at the top by a reinforced concrete beam. The sand and gravel for this pier had been placed on the south bank of the river before the close of navigation. This material was dredged from the bed of Lake Superior during the summer, and was used without screening. The mixing plant for this pier was located on the south bank, and the concrete was conveyed to the derrick by cars running on a track laid on the ice.

It was thought that difficulty might arise from the shrinkage of the concrete inside the shell, with a consequent destruction of the bond between it and the steel, and to prevent this, the first course of concrete was allowed to set under water, where some expansion would occur. The concrete in the piers was kept warm, where exposed to the air, by covering the piers and turning live steam into the enclosed space. The concrete below the ice line, and under water, was, of course, in no danger from freezing.

The steel shells were rendered watertight by caulking them at the laps, and by driving a small triangular wedge at the scarfs. The resistance of the material through which the shells were sunk was found to vary from 275 to 320 lb. per sq. ft. This is the net skin friction, after deducting the resistance caused by the cutting edge, the laps in the plates, and the rivet heads.

The cutting edges were reinforced by riveting, to the lower course of steel, an additional $\frac{1}{2}$ -in. plate, 3 ft. wide. This was considered sufficient, as the test borings had shown the material to be clear, and free from sunken trees or boulders.

The riveting and caulking were done with air, the compressor being of the locomotive type. Owing to the atmospheric moisture, the air line and hammers at

times gave some trouble, due to the intense cold.

The plates for the shells were punched and bent at Chicago and shipped ready for erection. They were fitted up easily and rapidly, as the work of bending and punching had been done well and carefully.

Work was carried on as rapidly as possible, three shifts being employed on the concrete at times. The total time consumed in this work, disregarding lapses and minor delays, was about five months. The cost of the two piers was about \$60,000.

The work came under the supervision of Mr. George A. Knowlton, division engineer in charge of the Lake Superior branch of the Grand Trunk Pacific Railway. The writer designed the lay-out of the plant and the method of construction, and was in charge of the work.

Road Construction Work by Grading Camp, Maintained by County.

Dallas County, Iowa, largely through the efforts of Mr. B. Stanton, County Superintendent of Roads, has developed an interesting method of doing county road work. Since 1898 the county has maintained a regular grading gang, which it has kept employed during the entire working season. Previous to this each taxpayer was permitted to work out his road and poll tax under a supervisor of the road district, the size of which varied from one-fourth to one-ninth of a township. The results were not satisfactory. Partial relief was secured by the passing of a legislative act allowing a one-mill county levy for grading and tiling. The County Board then decided to organize and equip a grading camp to be owned by the county and operated under the direction of the Board of Supervisors. It was also agreed that the oldest in point of service or retiring member of the board should have the entire use of the outfit and control of the work in his district for that year. This overcame the objection of long and expensive moving of the outfit to other parts of the county. The road work was then made continuous and well graded roads secured on mail routes and the main traveled roads to towns. This grading gang is under the supervision of a County Superintendent of Roads, and works under the direction of the Supervisors.

The county owned two wheelers, four scrapers and a road plow, and to this outfit they added a 5-ton road roller and an elevating scraper. With this outfit work was started in August, 1898. Four men and teams were first hired and the township in which the gang worked furnished two men and teams. The men secured board at nearby farmhouses, as no camp had been established.

The following spring a stable tent, a tent for the men to sleep in, and a well-built storm proof boarding house, 10x20 ft., mounted on wheels, and well painted in-

side and out, were added as camp outfit. New No. 2 contractors' wheel scrapers and a bladegrader were also secured.

Road work is begun early in April and is continued to December. A working force of 10 to 12 teams and 12 to 15 men has been found to make the best gang for steady and profitable work. In working a road, the camp ground is first located and the camp set up. The clearing gang is then started, followed by the elevating grader, harrows following the grader after that machine has made its round. A team from the clearing gang is used for harrowing, and subsequent clearing during the building of the grade. The wheeler gang is also started on some short work preparing for long hauls when the elevator has completed its work. Wheeler teams are also used on blade machine and roller during the building of the grade with the elevator. When the elevator has completed its work, all teams join the wheeler gang until started on another section of the work, leaving the first section to be finished by the regular wheeler teams, using the blade machine and thoroughly rolling the grade. From three to five miles of road are thus worked from one camp. The camp is then moved and the work continued. The equipment is kept in good repair and but little time is lost moving the camp to a new location. With a part of the force the camp is taken down, moved and set up at the next location in one-half a day. Active, sober and industrious men with good, heavy, well harnessed teams are selected for the grading gang, and a mutual and friendly interest among the men is maintained.

The boarding house is run by a man and woman, who furnish everything and make all they can out of it, boarding from 12 to 15 men and furnishing good board at \$3 per week. No rent is charged them for the use of the building. From 1898 to 1906 about 170 miles of road were worked under this plan, and it was found that with better and more complete equipment and more experience, better results were obtained than in the first years of the work. During 1906 30 miles of road were built, providing for good drainage. The grades in low ground were well covered with dirt and gravel from high ground, and drainage and top dressing were especially well cared for.

The average cost per mile of road work in 1906 was \$220, this cost including all expenses as follows:

	Per mile.
Running elevator grader.....	\$ 65.00
Running blade grader	15.00
Running roller	12.00
Wheeler work	80.00
Clearing stone, brush, stumps, etc....	15.00
Repairs on machinery and equipment, dynamite, wear and deterioration and interest on investment.....	15.00
Superintendence	18.00
Total	\$220.00

In 1907 all available money for county road work was about \$8,000. There are 11 incorporated towns in the county, each getting its proportion, which leaves about \$6,000 in the county grading fund. All expenses for help, repairs on machinery, camp equipment, etc., are paid from this fund. In addition each township in which work is being done either places its road gang at the disposal of the county, or contributes a portion of the cost, usually 50 per cent, from its road funds. About \$10 per mile is also secured as a bonus from farmers living along the road to be improved. Only main traveled roads are considered and in each locality that road is selected which offers the largest cash bonus.

The county superintendent of roads, who has charge of the grading gang, keeps all accounts. He is authorized by the county board to hire a sufficient number of men and teams to do the work. The board makes the price for men and man and team per day of ten hours. The superintendent keeps the time and sends a duplicate time sheet to the auditor for each two weeks. This sheet shows the amount due each man for this period. The county treasurer deposits the aggregate amount in a convenient bank to the credit of the superintendent to cover this expense. The superintendent keeps ledger account with each man, paying all board and feed bills for the two weeks and gives him bank check for his time for the two weeks, less the above expenses. Merchandise accounts, blacksmith bills and all other expenses are shown by itemized statements receipted by them. These bills are also paid by the superintendent and the statement of same sent to the county auditor with the time sheets. The superintendent keeps ledger account with the auditor and with the treasurer and settles with them and the board of supervisors at the close of

The Results of Temperature Observations in Masonry.

In building the Boonton dam at Boonton, N. J., for the Jersey City Water Supply Co., the engineer for the company placed within the dam, while in the course of construction, 11 Whipple-Warren thermophones. These were all placed in one section of the dam that was about 100 ft. high, and were so arranged as to show the temperatures of every part of the masonry. These thermophones were supposed to give the temperature within a degree.

The Boonton dam was built during the years 1902, 1903 and 1904. The masonry part is 2,150 ft. long, the average height being 90 ft. The dam was built of cyclopean masonry of which approximately 50 per cent was concrete and 50 per cent large stones. The up-stream face was rubble, while the down-stream face was ashlar.

In a discussion of a paper read before the American Society of Civil Engineers by Charles S. Gowen on The Effect of Temperature Changes in Masonry and published in the Proceedings of the Society for 1908, Mr. Thaddeus Merriman (Proceedings, Vol. XXXIV., Aug., 1908, p. 620) gives the results of the observation made by means of the thermophones at the Boonton dam.

During the first winter, 1903-4, cracks occurred in the masonry that had been built the previous season, except that put in during November and December. The weather during these months was very cold and the masonry put in was frosted. Before the winter of 1904-5 the dam was completed and cracks appeared in this part of the masonry and all of the old cracks opened up again. During the succeeding winters no new cracks have been observed, but the old cracks have all reopened, but not always to the same extent. Only through the largest cracks has any seepage of water

RESULTS OF THERMOPHONE OBSERVATIONS, BOONTON, N. J., DAM.

Coil No.	Distance from face, in ft.	Maximum temperature, Degs. F.	Date of Maximum Temperature.	Minimum temperature, Degs. F.	Date of minimum Temperature.	Total temperature range in Degs. F.
5.....	2.0	69	Aug., 1904	39	Mar., 1905	30
6.....	11.3	64	Sept., 1904	45	Mar., 1905	19
8.....	11.0	63	Sept., 1904	43	Mar., 1905	20
9.....	2.5	71	Aug., 1904	34	Mar., 1905	37
10.....	16.0	68	Oct., 1904	46	Mar., 1905	22

the season, at which time plans are discussed and under consideration for the next year's work.

The results have been very satisfactory, so much so that in 1907, the county placed an additional fully equipped grading gang in the field, maintaining both gangs during the entire season. Rural mail routes and main traveled roads are the only ones that have been worked. Some graveling has also been done.

A new all-the-year-round ice skating rink was opened in Berlin, Germany, on Sept. 1. This makes the fourth permanent ice rink in Europe, the others being located in London, Paris, and Munich. The surface of the indoor pond at Berlin is 2,000 meters square.

occurred. The seepage being greater in winter than in summer.

At various times trouble was experienced in the operation of the thermophones, and gradually the coils, one after another ceased recording, until at this time none are giving reliable results.

The accompanying table shows the principal results obtained from the thermophones. It will be noticed that no observations were used in the compilation of this table until the thermophones had been in place for practically a year.

This was done in order to eliminate, if possible, the effect of the heat generated during setting. The results shown in this table were then plotted on the diagram Fig. 1, and by trial a curve most closely representing the observations was drawn

If R be the total range in temperature at any point in the mass, in degrees, Fahrenheit, and D be the distance in feet to the nearest face of the dam, then

$$R = \frac{135}{3\sqrt{D}}$$

Where 135 is the total atmospheric range, as observed during the period from June, 1901, to March, 1905. During this period the minimum temperature reached was -18° F., and it is estimated that the minimum in the sun was 117° F., that in the shade being 98° . This value, 135, is also probably not far from the maximum atmospheric range attained in the latitude of New York.

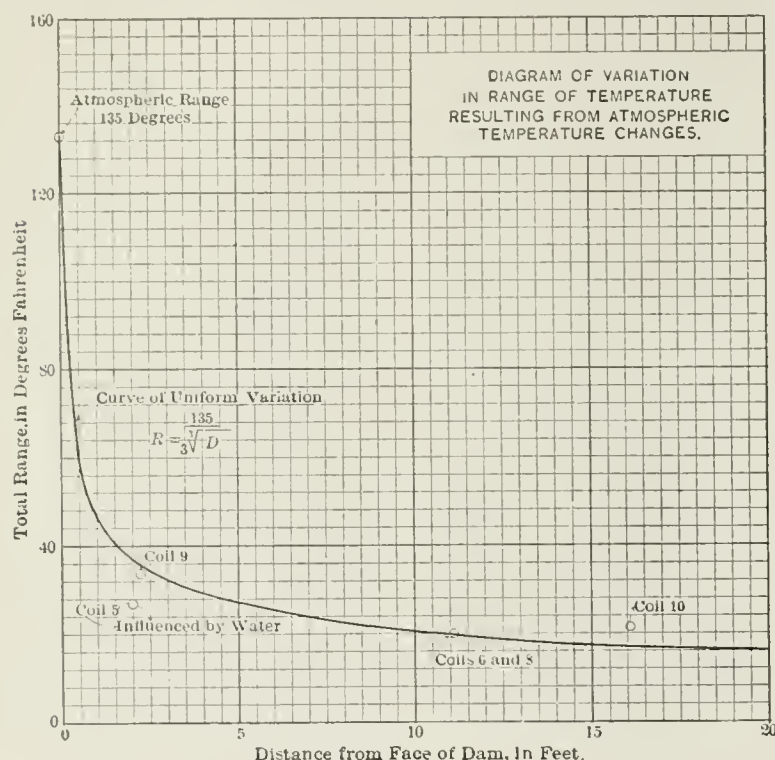


Fig. 1.

Referring to the diagram, it is seen that the curve represented by this expression fits the plotted points closely, therefore it has been adopted until future observations indicate that a change would be advisable. It must be noted that near the minor limit the curve does not seem to fit in with the physics of the case, as it indicates that the range could never be zero.

Work is to be begun this year, according to a Consular report, on rebuilding the Trans-Siberian Ry. in the mountainous districts between Achinsk and Irkutsk. The cost of the work will be about \$18,579,000.

As a result of the epidemic of cholera at St. Petersburg, Russia, the city and governmental authorities are taking steps to secure the installation of a new sewer system to cost about \$40,000,000.

Gold and silver of a total value of \$17,479,574 were produced in California in 1907.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *ENGINEERING-CONTRACTING*. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0892. **Steel Dump Cars.**—Ernst Wiener Co., Morris Bldg., New York.

A 26-page pamphlet description of the work done on the new Pennsylvania R. R. and the Hudson Terminals, tunnels and ter-

arguments for the efficiency and economy of the type of rock made by the company named. The several sizes of drills are briefly described.

No. 0897. **Expanded Metal Information.**—Northwestern Expanded Metal Co., Chicago, Ill.

The twelve pages of this pamphlet contain really useful information. Floor loads, test loads, estimating data, properties of concrete and steel, mechanical bond, etc., are some of the matters considered. Tables of sizes of expanded metal are given and also formulas for beams.

No. 0898. **Wemlinger Steel Sheet Piling.**—Wemlinger Steel Piling Co., New York, N. Y.

This large folder contains a number of good illustrations of Wemlinger steel sheet-piling under test and in actual structures and also gives a very clear statement of the merits of the type.

No. 0899. **Kahn Bar Beam Tests.**—Trussed Concrete Steel Co., Detroit, Mich.

This circular gives the result of comparison tests made on concrete beams reinforced with Kahn bars and with square bars having loose vertical stirrups. The tests are briefly discussed.

No. 0900. **Anhydral.**—The North Jersey Paint Co., Stewartsville, N. J.

This six-page circular describes the new waterproofing compound of the above name. This compound is applied with a brush like paint, a gallon giving two coats to prime 90 to 135 sq. ft. The circular is worth receiving.

No. 0901. **American Ditcher.**—The American Ditcher Co., Humboldt, Iowa.

The ditcher described in this four-page circular is of the wheel type, and is novel for that type in having self-cleaning buckets.

No. 0902. **Industrial Cars and Locomotives.**—Ernst Wiener Co., New York, N. Y.

This series of seven 6 x 9-in. pamphlets gives sizes, capacities, descriptions, illustrations, etc., of narrow gage locomotives and cars. The variety of styles of cars shown covers almost all kinds of industrial and contractors' work, but the rocker dump car and the steel frame wooden platform car shown in two of the pamphlets are of particular interest to contractors. Narrow gage track is also shown in all varieties.

No. 0903. **Hoisting Machinery.**—Parker Hoist & Machine Co., Chicago, Ill.

This company manufactures a full line of engines, derricks, cranes, crabs and supplies. The various machines are illustrated and described in this 125-page catalog with tables of sizes, capacities, etc., etc.

No. 0904. **Steel Ribs and Lagging.**—George W. Jackson, Inc., Chicago, Ill.

Under the above name this pamphlet describes and illustrates a steel centering and form for concrete lining for tunnels, sewers, shafts and conduits generally. This center consists of a standard channel lagging plate which is universal and of channel ribs which are altered for each size and shape of section. The pamphlet shows the numerous places in which the steel ribs and lagging has been used and gives full information concerning its erection, economy, etc. Contractors for concrete tunnel and conduit work should look into the merits of this device.

No. 0905. **Model Gas Engines.**—The Model Gas Engine Co., Auburn, Ind.

The 30-page general catalog of its various engines that this company issues is one of the best descriptive catalogs that we have seen recently. General power, portable and hoisting engines are described, and contractors will find much to interest them in the matter relating to the hoisting engines. Separate pamphlets are issued on Model four-cylinder gas and gasoline, four and eight-cylinder marine engines and gas producers.

No. 0906. **Masons' and Plasterers' Tools.**—Marshalltown Trowel Co., Marshalltown, Ia.

This catalog illustrates and gives prices, sizes, etc., of trowels, floats, sidewalk tools, brick hammers and chisels, etc. The line of tools shown is a particularly good one and cement workers should secure the catalog.

No. 0907. **Fencing.**—The Denning Wire & Fence Co., Cedar Rapids, Ia.

This pamphlet shows a line of wire fencing for farms, lawns, etc., with fence builders' tools and supplies. Among the specialties shown are the "Pyramid" reinforced concrete fence post.

No. 0908. **Stone Crushers.**—Universal Stone Crusher Co., Cedar Rapids, Ia.

This circular shows a number of sizes of Volten crushers at work and gives capacities, weights, etc. The crusher has several unusual features and is worth learning about.

minals in New York city. On this important work a large number of Wiener cars were used and illustrations are shown of these and many other construction features.

No. 0893. **Reinforced Concrete Pipe.**—Lock Joint Pipe Co., 165 Broadway, New York.

A bulletin showing the method of casting the continuous concrete sewer pipes and conduits manufactured by this company under the Meriwether System. The advantages of this pipe are set forth, one being that it is manufactured in close proximity to the work, where it is to be used.

No. 0894. **Rock Crusher.**—Smith & Post Co., Milwaukee, Wis.

In this 24-page catalog the Symons crusher is described and the many advantages of this style of gyratory crusher, claimed by its manufacturers, are pointed out. The height of this crusher is much less than most other crushers of this type, which it is claimed is a distinct advantage over other makes. Crusher accessories are also listed in this catalog.

No. 0895. **Concrete Mixers.**—The T. L. Smith Co., Milwaukee, Wis.

A new catalog telling of the Smith mixer. This mixer is so well known to contractors and engineers that it is almost useless to write of it. However, the catalog shows the various sizes of machines made, the principles of mixing and charging and many other things of interest to the maker of concrete. This company has lately put on the market a 2 cu. yd. batch mixer.

No. 0896. **Improved Wood Rock Drills.**—Wood Drill Works, Paterson, N. J.

This little pamphlet presents a number of

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**Henceforth This Journal Will Print
More Than 1,000 Pages of
Articles Yearly.**

Beginning this month, there will be an increase in the number of pages of articles in this paper, amounting to 240 pages a year, which will bring the total to more than 1,000 pages annually. This does not include our weekly contract news, nor our monthly review index of current civil engineering literature.

The reader will have a better idea of what these 1,000 pages of articles really mean if he converts them into pages of the ordinary 6x9 in. text book. One page of ENGINEERING-CONTRACTING contains 3 times as many words as the average text book page. Hence the 1,000 pages of this journal are equivalent to one 3,000-page text book of the standard 6x9 size, or to 6 such books averaging 500 pages each. The reader would pay \$20 to \$25 for an equivalent amount of reading matter in text book form, yet he buys it in journal form for \$2, and gets nearly 400 pages of contract news besides.

It is needless to say that so low a price for a technical periodical of this size could not be given were it not for the additional income that the periodical receives from its advertisers.

We could take no pride in a mere bulk of paper spread thick with words, but we do look with satisfaction upon a growth in size that is not effected at the expense of quality of reading matter presented. ENGINEERING-CONTRACTING has a larger editorial staff than any engineering journal in America, with one exception, and it is equal to that exception. To do conscientious editorial work for a paper that has grown to this size, requires not fewer than five men. Moreover, it is desirable to have the five editors, in order to combine a variety of experience that will cover the entire field of civil engineering and contracting.

It is our plan to add another editor to the staff and make a further increase in the number of reading pages early next year, provided the number of our advertisers maintains its steady increase. Therefore, we trust that our readers will continue to have the kindness to mention ENGINEERING-CONTRACTING when writing to our advertisers for prices, catalogs, etc. Such mention proves to the advertiser that his advertisement is bearing fruit. It enables him to recommend the paper to other advertisers, as exemplified in the 45 letters of recommendation which will be found in the advertising pages of this issue.

At this time it is not amiss to call attention to the fact that the 1,000 pages of articles which our readers will receive will be devoted exclusively to civil engineering and contracting subjects. We are making no attempt to interest mining engineers, mechanical engineers, etc. We are address-

ing the civil engineers and contractors only, and in this respect ENGINEERING-CONTRACTING is unique. It is the only general engineering periodical that confines itself strictly to the civil engineering and contracting field. For that reason its 1,000 pages a year will be found to contain more matter of interest to civil engineers and contractors than will be found in any other American journal in the same period of time. This is a promise that we ask our readers to test by the last year's performance. We make the promise not merely to obtain the co-operation of our readers in getting still more readers, but in order to set for ourselves a definite goal.

Again we ask each of our subscribers to send us the address of some active engineer or contractor to whom we may send a sample copy of ENGINEERING-CONTRACTING. If you do not do so now, kindly do so when you renew your subscription.

**The Engineering News' Explanation of
the Alleged Superiority of
English Macadam.**

"I believe, from all the information I have been able to obtain, that the difference in wearing qualities, in dust and in mud of English and American macadam roads is due almost wholly to one very simple cause, which, so far as I am aware has never been pointed out. I believe the whole explanation of the mystery lies in the fact that *American horses are shod with sharp calks, while English horses are smooth shod.*"—Editorial Correspondence by C. W. B. in Engineering News, Sept. 24, 1908, p. 338.

The News correspondent then proceeds to compare English with American macadam roads, or at least with the variety of American macadam with which he is familiar, namely, the macadam of northern New Jersey. He says:

"In my own home town of Montclair, N. J., a suburban residence town of less than 20,000 population, and no manufacturing industry, ordinary macadam is being abandoned as a paving in the main streets."

And, again, he says:

"It is nothing uncommon to see dust like fine flour a considerable fraction of an inch in depth on our New Jersey roads. When rain comes this dust is promptly converted into mud."

After adding that trap rock of the very best quality in America is used in building these New Jersey roads, the News correspondent arrives at the explanation of their dirtiness given in the quotation at the head of this article. He ascribes it all to the fact that "American horses are shod with sharp calks."

That this generalization is a correct view as to New Jersey we dispute, and we further deny that New Jersey macadam is typical of macadam in other American states, as the News correspondent seems to think.

When the managing editor of Engineering-Contracting was on the editorial staff of Engineering News, he also lived for a time in Montclair, N. J., and noted with interest how radically different were the methods of building macadam in New Jersey from the methods that he himself had used elsewhere; and he wrote an editorial commenting upon those differences, which appeared in Engineering News, Aug. 27, 1907, page 182. We quote:

"This wearing coat is 3 ins. thick and consists of stones not over 1½ ins. in diameter. *It is not rolled at all before binding, but earth from the sides of the street is cast upon the stone to the depth of about an inch, then the rolling begins* * * * Towards the last of the rolling some trap rock screenings are spread over the macadam, more for appearance sake than for anything else. * * *

"As to the binding of the 3-in. wearing coat entirely with earth we cannot speak so favorably; for while a fairly good surface is produced by present methods, it by no means equals in durability macadam that is bound with stone screenings."

The reader will note that the use of earth for a top binder was specifically pointed out as not giving as good a road as is obtained by use of stone screenings.

The true cause of the supreme dirtiness of many New Jersey roads is the dirt that is put into them during construction. This was clear to the writer in 1903, at a time when automobiles were not numerous. It is clearer than ever now. Moreover, a macadam bound with earth is not as resistant either to horse's calks or to the rubber tires of automobiles as a macadam bound with stone screenings. The earth has not the "cementitious" power that stone dust has, and the stones are, therefore, displaced with greater ease.

In elaborating his theory that horse's calks are responsible for the relatively poor condition of New Jersey roads, the Engineering News correspondent says:

"All this, and more, is the price we are paying in the United States for following the custom of putting sharp calks on horse shoes. It is a custom without doubt, which has grown out of the former universal prevalence of dirt roads, *where calks are essential to give a horse a sure foothold at all times.* (The italics are ours.—Editors.) In England *all* roads are macadamized, and have been for so long a time that the necessity for calks on shoes long ago disappeared."

The facts are just the reverse of those above stated. Calks are *not* essential on earth roads or on farms. Indeed, many farm horses are never shod at all, because they are not required to walk on paved roads. A horse needs neither shoes nor calks to give it a foothold on an earth road.

It is, furthermore, not a fact that American horses are sharp shod, except in winter time, and then only where they are

required to travel over paved streets or roads where ice and snow make walking dangerous for a smooth shod horse.

The correspondent of Engineering News closes his article in the following words:

"But whatever can or cannot be done [To do away with the use of calks in America—Editors], it is certainly well that the true cause of the inferiority of American macadamized roads should be known and that American engineers and road builders should no longer be accused of ignorance and incompetence."

We were not aware that they were being so accused, as a class. The fact is that there is a woeful ignorance, even as to macadam, to be found in many individual cases. But American engineers, as a class, know how to build as good macadam as can be, or is, built anywhere. The writer has built macadam, which, until the advent of the automobile, was as hard, smooth and clean as a floor. No stones were ever picked loose by horses' calks, and dust did not lie upon its surface, which was purposely given a sharp crown so that rains would wash it clean.

Engineers to-day, however, are confronted with the problem of saving macadam roads from utter destruction by automobiles, and not by the calks on the shoes on horses. We are of the opinion that this new condition will completely revolutionize methods of road building. Broken stone will doubtless continue to be used extensively, but some sort of a binder other than stone dust or earth must be employed. Thus far, asphaltic and tarry binders have produced the best results, and bid fair to have the most extensive use in the immediate future.

The Names of 1080 Applicants for Membership in the American Society of Engineering Contractors and the Objects of the Society.

Several attempts have been made during the past decade to organize a national society of contractors, but with indifferent success. Hence the managing editor of this journal determined not to issue a call for the final organization of the American Society of Engineering Contractors until such time as he had received fully 1,000 applications for membership. While this seemed at first like an almost prohibitive number to expect to obtain for charter membership, nevertheless the response was so earnest and the inflowing applications so steady that it seemed wise to adhere to the early plan of waiting until the full 1,000 applications had been filed. That time has now arrived, and on the following pages will be found the names of nearly 1,100 contractors, engineers and manufacturers who wish to be enrolled as charter members in this national organization.

While we have, from time to time, outlined the main objects of this society, it is

proper to give a brief resume now that the final organization is about to be perfected. Before doing so, however, we wish to draw a brief comparison between the inception and growth of the great American Society of Civil Engineers and of this American Society of Engineering Contractors.

The American Society of Civil Engineers was organized in 1852 with a charter membership of only 50 men, and it was not till 1886—after 34 years of existence—that it attained a membership of 925. It now numbers 4,700 members of all classes.

The American Society of Engineering Contractors will start with 1,100 or 1,200 applications for membership, since there will be several score who will respond to this appeal in addition to those who have already responded to previous appeals. Hence this new society will organize with a membership exceeding that possessed by the American Society of Civil Engineers at the end of 34 years of effort. It seems superfluous to add that this is a phenomenal beginning for any society, but we wish to emphasize the fact that a great latent demand has long existed for an organization such as this. That it will soon exceed in membership the American Society of Civil Engineers no one can doubt after this evidence of initiatory strength. Indeed we see no reason why at least 90 per cent of our readers should not join the society, in which case it will have double the membership possessed by the American Society of Civil Engineers. But even such a membership as that will be only a beginning. The society should double again in a few years and attain a membership of not fewer than 20,000 men. There are far more than that number of contractors alone, to say nothing of an equal number of civil engineers whose interests are such that membership in the American Society of Engineering Contractors will be of the greatest advantage.

Now let us briefly enumerate some of the ends that such a society of contractors and engineers may hope to attain. We place contractors first in order of mention, but, in truth, the society is one in which engineers should and will have great influence. It will be the common meeting ground for the men who design structures and the men who build them. Before this society, as a tribunal, will be presented arguments for and against certain forms of specifications and contracts. Committees of this society will, for the first time in history, represent the two points of view and work out equitable solutions of the problems involved in writing specifications for civil engineering construction.

Millions of dollars will be saved annually to the national government, to states and municipalities, to towns, villages and counties, to railways and other industrial corporations who engage engineers to supervise contract work. We say millions advisedly. The writer has spent an almost equal number of years in

the practice of the profession of civil engineering and in the business of contracting. He knows the great possibilities of more economic design that will be realized when engineers and contractors work in harmony. He has seen vast public works go begging for a contractor, because of the fact that the engineers in charge had so drawn specifications that no reputable contractor dared bid on the work. He has seen those same engineers attribute their failure to receive bids to every cause but the true one, and finally do the work by day labor at great loss to the public because of the inefficiency of men working by the day for the government.

All this loss could have been prevented had the American Society of Engineering Contractors been in existence.

Aside from these enormous losses—such as are well illustrated to-day in the work of building the Panama Canal by day labor—there are innumerable smaller losses that aggregate enormous sums. There are the losses due to law suits over ambiguous clauses in specifications. There are the losses due to unnecessary exactions in specifications. There are losses due to skimmed work as the direct result of an effort to "get even" for some unreasonable requirement on another part of the job. Finally there are the vast corruption losses due to the political rings, like those that disgrace Philadelphia, where the laws are violated in one way or another and contracts let to the favorites of those who are in political power.

Every one of these losses will be reduced and many of them eliminated entirely by a militant organization of engineering contractors. We want in this organization no contractor who feeds upon political corruption. He will find it no place to his liking if he does get into the society, for one of the great aims of the American Society of Engineering Contractors will be to throttle graft wherever it may be found.

This society will be confronted with the problems that arise from the occasional

unfair aggression of labor unions. Hitherto there has been no national organization of contractors to meet the representatives of labor unions and treat with them, body to body. Against labor unions the worst that can usually be said is that they frequently cease to obey the laws of true political economy both by limiting the daily output of men and by attempting to restrict the number of apprentices. In their struggles for liberal wages we have the greatest sympathy. But where there is great power unopposed, there is sure to be bred abuse of that power. Men work out their destiny best by conflict, man against man, principle against principle. Then neither deaf conservatism nor blind radicalism can have its way unchecked. To meet the national organization of laborers there should be a national organization of contractors. For the first time it is now evident that such an organization is about to exist.

In addition to these important and unique features, the American Society of Engineering Contractors will possess features common to other societies of a technical nature. The large present-day contractor is either a natural born or trained engineer himself, or has an engineer in his employ. Hence the business of contracting is more than a business. It is also a technical profession. Into its ranks hundreds of engineering graduates have gone and hundreds more are going. Contractors of the old school have been sending their sons to engineering colleges. A silent revolution in the business of engineering-contracting is now in progress, and has been in progress for several years past. The natural born engineering-contractor is a natural born engineer, but he recognizes the advantage of an engineering training. He seeks it either for himself or for his son, or he hires it in the person of a trained engineer.

Where shall the modern contractor and his engineer find a meeting place to exchange ideas with others? There has been no society until now that could answer by

saying "Here." We entertain no dreamer's vision when we predict that the Transactions of the American Society of Engineering Contractors will contain technical papers that will be priceless. As gatherers of articles on methods and costs, the editors of this journal have found that hundreds of contractors gladly give out for publication much of the valuable results of a life-long experience. They entertain a professional pride in their work and the economic execution of it, and they are as willing to exchange ideas as are men of strictly professional standing. Hence our belief in the intrinsic worth of the papers that will be presented before this society.

The society dues should never be made large, and it is particularly desirable that the charter members be burdened as lightly as possible. We suggest that there should be three classes of members in this society: (1) Contracting Members, (2) Engineering Members, and (3) Manufacturing Members.

Since the contracting and manufacturing members are those who will receive the greatest direct benefits of the society, they should bear the heavier burden of about \$10 annual dues.

The engineering members should not be required to pay more than about \$5 annually.

While these are low dues, we believe that they will prove ample, in view of the large membership that the society can count upon from the very start. We shall welcome expressions of opinion and suggestions from applicants for membership, before putting the matter to a vote.

All who have not applied for membership are urgently requested to fill in the application blank which will be found on advertising page 16. We also repeat our request that the names and addresses of possible applicants for membership be sent to Mr. Gillette, so that application blanks may be sent to all who may be interested.

In a subsequent issue the first meeting of the society will be announced.

The list of names follows:

Abadie, E. H.
Abbott, Herbert N.
Acret, George E.
Adams, Harry C.
Adams, W. H.
Adkins, H.
Ahlborn, Theodore
Alexander, Henry F.
Allen, M. E.
Allen, Walter H.
Allen, Wilton O.
Alter, Lewis S.
Altsaetter, F. W.
Amerman, Melvin R.
Anderson, A. H.
Anderson, Clark G.
Anderson, F. W.
Anderson, Harry W.
Anderson, J. C.
Andrews, I. A.
Andrews, Morton C.
Andrews, William M.
Andrews, W. P., Jr.
Angsbach, E. H.
Annan, J. P.
Antonisen, J.
Arnold, Walter T.
Arthur, William S.
Artingstall, William
Ashbjornsen, M. G.
Ash, Dorsey
Ashcroft, G. B.
Austin, S.

Bachman, Robert A.
Backus, Orrin
Bacon, Edward R.
Bacon, George M.
Bacon, James H.
Baggott, C. W.
Bailey, Robert W.
Bailey, J. W.
Bailey, Orin P.
Baker, John S.
Baker, Roscoe W.
Balcumb, Jean Bart
Ballingier, R. E. C.
Balsley, E. A.
Bumford, W. B.
Bandy, E. L.
Parhorn, Frank A.
Baker, J. K.
Barney, C. P.
Barth, Edmund A.
Bartlett, Charles H.
Bartlett, C. L.
Bartlett & Kling
Bassett, H. M.
Baumgarner, Charles H.
Baxter, D. E.
Bean, W. Worth, Jr.
Beatty, J. E.
Beaty, R. Ernest
Beaudry, D. L. de S.
Bedell, Ira D.
Reebe, J. W.
Reekman, Wm. Schuyler
Beet, John
Beezley, B. F.

Bell, Charles H.
Bell, George I.
Bellingrodt, M. O.
Belzner, Theodore
Benham, W. L.
Bennett, Charles N.
Bennett, James C.
Benson, J. A.
Benson, J. F.
Bent, Arthur S.
Bentzon, A.
Bernstein, Mariz
Bery, Leslie H.
Bengler, Hugh M.
Bierbaum, C. H.
Bizzgers, Arthur W.
Billings, A. W. K.
Billings, F. M.
Birch, Fred
Bishop, William Israel
Bishop, W.
Bixby, Lt. Col. W. H.
Black, John Cecil
Blackmar, George G.
Blair, A. F.
Blake, H. C.
Blanchard, Arthur H.
Blinn, Ray S.
Blose, Ira F.
Boardman, H. B.
Bolton, Channing M.
Bonner, Harry E.
Booker, S. E.
Bosch, Frank R.
Bowers, A. B.

Bowers, K. C.
Bowman, Archibald
Boyd, J. Leonard
Bradford, George H.
Bradley, Clifton
Brady, John M.
Bray, Jas. R. D.
Breckinridge, Caball
Brenn, C. F.
Brewster, Henry B.
Briddele, G.
Bright, F. W.
Brillhart, Jacob H.
Brooks, H. W.
Brotherton, D. A.
Brown, Charles F.
Brown, E. T.
Brown, Elmer W.
Brown, Frank D.
Brown, John G.
Brownlee, A.
Bruce, J. M. & Co.
Bryan, J.
Bryant, H. H.
Bryson, Thomas B.
Buck, Thad E.
Budd, Henry F.
Buddell, A. E.
Buman, C. S.
Bunker, G. W.
Bunker, Walter E.
Burch, Fred
Burke, M. C.
Butcher, Joseph F.
Byers, Archibald F.

Byrne, A. T.
Byxall, Frank D.

Cacevajo, Joseph
Caddell, W. P.
Calahan, James P.
Caldwell, J. S.
Callman, Herbert
Cameron, John B.
Cameron, M. A.
Camp, Oswald Edward
Campbell, Albert J.
Campbell, Albert Park
Campbell, William
Carmichael, William P.
Carpenter, C. L.
Carpenter, L. G.
Carter, H. H.
Carter, Lewis Conner
Carthy, Ambrose
Carver, D. W.
Case, Benjamin H.
Cast, W. B.
Castle, D. S.
Cathroe, H. J.
Catlin, E. H.
Caton, William H.
Chandler, Prof. E. F.
Chandler, Albert N.
Chase, Marvin
Chester, C. P.
Chisom, George F.
Christenson, G. A.
Christie, R. L.
Class, C. Frank
Clawiter, Edward J.
Clemons, Robert S.
Clement, E. Hayes
Clement, Harrison
Clendon, F. R. W.
Cluxton, M. W.
Codd, C. E.
Coggen, C. J.
Cole, G. Percy
Cole, Howard J.
Coleman, John B.
Coleman, John F.
Coles, Charles E. N.
Collins, A. B.
Collins, G. A.
Collins, George C.
Collins, George H.
Coltman, Robert
Concanon, William N.
Conlon, F. T.
Connick, Harris D. H.
Conolly, L. B.
Conrad, L. E.
Considine, Eugene F.
Cooney, Charles F.
Copland, A. C.
Corbet, William Noel
Core, M. O.
Corriveau, R. de B.
Corwin, W. B.
Cosgro, J. B.
Coupe, Alfred L.
Courter, Guy W.
Cowen, W. H.
Craig, H. B.
Craven, J. T.
Creden, William L.
Crooks, John A.
Crookshank, A. R.
Crum, E. C.
Cryder, H. M.
Cudeworth, F. C.
Culver, Archibald E.
Cummings, Robert A.
Cunningham, F. B.
Cunningham, Max L.
Currie, F. T.
Cuzzo, Donato

Dalley, Daniel S.
Dalley, Henry S.
Dailley, Joseph A.
D'Ailly, Richard
Daris, Fred
Davids, William C.
Davis, C. S.
Davis, C. S.
Daw, Hilder
Dean, Bertram D.
Decker, John H.
De Groot, J. P.
De Kinder, J. J.
Dennis, Wm. F.
Denton, H. H.
Des Granges, John C.
Des Meules, S. A.
De Hart, C. D.
Detwiller, H. E.
D'Hemecourt, G. A.
Dickey, James
Dinsmore, M. R.
Fixey, Wm. D.
Donald, R. L.
Donnelly, W. J.
Dud, A. T.
Doyle, Thomas F.
Dukker, D. H.
Duler, John
Duncan, Erskine
Dyleman, Conrad F.

Eastman, S. P.
Easton, F. L.
Easton, K. G.

Eckhard, Christian
Edge, A. B.
Edgerly, R. J.
Edmonds, A. Braxton
Edsall, J. C.
Edwards, J. T.
Edwards, Oliver C.
Eddy, John W.
Ege, C. R.
Egleston, Howard
Ehlers, Paul H.
Elfrith, Harold D.
Ellingwood, E. L.
Elliott, L. B.
Ellsworth, A. W.
Elisca, R. H.
Elsmore, W. C.
Ely, G. Wells
Emerson, F. M.
Engel, B. N.
England, P. W.
Eppelle, Frank J.
Erwin, Henry
Erwin, M. C.
Evans, David E.
Evans, George H.
Evans, Hobart J.
Evans, Jos. D.
Evans, J. L.
Evans, W. J.
Eynes, Herman H.

Fairchild, C. D. V.
Farrington, Henry
Farris, William
Faust, Frank C.
Felsenhauser, Frank J.
Fellows, A. L.
Ferguson, J. E.
Fillion, E. E.
Fisher, Fred
Fisher, Janon
Fisk, G. H.
Fitzgerald, P. S.
Fitzgerald, Wm. J.
Fitz Randolph, W. S.
Fixmer, Hugh J.
Flagler, J. M.
Flaherty, W. H.
Foley, John
Fonda, Arthur I.
Ford, B. M. O.
Ford, P. D.
Ford, William B.
Fortney, W. H.
Fouilhous, J. Andre
Fowler, Frank G.
Fox, Charles Kirby
Foye, Andrew E.
Francy, E. E.
Frazier, Thos. H.
Freeland, John A.
Freeman, Geo. W.
French, C. J.
Frisbee, Jerome B.
Fritz, A. L. G.
Frost, Geo. P.
Fuce, Edw. O.
Fuller Co., Andrew D.
Fusco, James J.

Garretton, W. F.
Gay, Robert W.
Gaynor, K. C.
Gemmer, Walter S.
George, E. M.
George, H. M.
George, James Z.
Gere, G. H.
Gibbs, Chas. H.
Gibbs, Nathan J.
Gibson, Harold H.
Gilbert, H. L.
Gilbreth, Frank B.
Gilkison, W. D.
Gillette, Cassius E.
Gillette, Halbert P.
Gillette, Walter A.
Gilmour, W. J.
Gilmor, Harry
Girder, L. T.
Girth, George C.
Gladding, James N.
Gloyd, James R.
Goerke, James F.
Goldie, E. C.
Goodwin, George E.
Gordon Engineering Co.
Grace, Richard J.
Grady, Walter J.
Grafton, T. E.
Granberry, J. H.
Grant, H. B.
Gray, Henry L.
Greany, William C.
Green, Chas. N.
Greene, R. M.
Greensfelder, A. P.
Grider, L. T.
Gridley, F. B.
Griffin, M. J.
Griffith, Geo. L.
Grimes, E. L.
Grimshaw, Wm. B.
Griswold, H. J.
Griswold, W. H.
Groh, Bernard C.
Gron Dahl, A. K.
Grossart, A.
Grossart, L. J. H.

Gunn, James Newton
Gurin, P. M.
Guttridge, Jas. A.
Hackedorn, Willis F.
Halmovlvi, J. A.
Hall, Louis C.
Hallman, J. P.
Hamilton, Chas. F.
Hanks, Louis B.
Hansen, Otto
Hanson, E. E.
Haring, Prof. Alexander
Harman, Jacob A.
Harms, Harry J.
Harms, John
Harper, Fred C.
Harrington, W. D.
Harris, George M.
Harris, W. Francis
Harris, W. R.
Harris, W. R.
Harrison, H. L.
Harrop, John T.
Hart, A. L.
Hart, Everett W.
Hart, Reuben C.
Haskins, Wm. J.
Hauer, Daniel J.
Harvey, F. S.
Hawley, John C.
Hayden, Wm. H.
Hayne, C. G.
Hays, Wm. D.
Hazen, W. B.
Heaton, Augustus
Hedden, E. B.
Hegardt, G. B.
Heiges, T. Tyrrell
Heller, H. E.
Heller, P. M.
Henderson, Herbert
Henderson, Horace P.
Henrigues, Vernon C.
Henry, A. R.
Hermans, W. J.
Hermans, Frank A.
Heuser, Chas. U.
Hewerdine, T. S.
Heywood, R. C.
Hezlep, A. C.
Hicks, Hervey B.
Hicks, Lewis A.
Hill, Charles S.
Hill, F. A.
Hills, W. L.
Hingston, E. Clarence
Hirst, S. M.
Hitchcock, F. C.
Hobby, Arthur S.
Hogue, Gilbert H.
Holler, John M.
Hollingsworth, C. H.
Holman, M. L.
Holmberg, P.
Holmes, E. M.
Hoover, Frank E.
Horn, F. C.
Hortigan, Wm. James
Hoskinson, John F.
Horstmann, Edward, Jr.
Hoskins, Jones H.
Howard, Clement J.
Howard, J. W.
Howe, H. F.
Howes, Benj. A.
Howley Construction Co.
Hoyt, Robert C.
Hubbard, I. Wendell
Huber, F. A.
Humphrey, George R.
Hunt, Leigh
Hunter, H. G.
Huntington, L. M.
Hurst, George J.
Hurst, N. C.
Huston, T. L.
Hutchinson, Geo.
Hyde, E. W., Jr.
Hyde, Herbert

Ide, C. W.
Iglesder, Francis X.
Ingersoll, F. B.
Ingle, J. L., Jr.
Innes, Harry C.
Irwin, W. A.

Jackson, George W.
Jacolson, S. L.
Jacoby, A. H.
Jacoby, C. E.
Jandt, Chas. H.
James, L. M.
Jeansen, Carl F.
Jenkins, W. E.
Jenssen, L. N.
Jones Bros.
Jones, Edward
Jones, H. Meredith
Jones, Jos. L.
Joseph, L. S.
June, Robert F.

Kahler, C. P.
Kahn, Julius
Kaufman, Gustave
Kasten, F. W.
Kelly, Earl W.
Keely, R. R.
Kelly, Joseph G.
Kelly, J. W.

Kemper, Walter Y.
Kenyon, Howard
Kerner, Martin T.
Kern, Joseph F.
Kershaw, C. G.
Ketchum, Milo S.
Kettlewell, H. I.
Key, Jno. R.
Keyser, F. W.
Kilpatrick, H. B.
Kilpatrick, W. G. H.
Kim, Jos. F.
Kinhead, D. R.
Kinsley, C. R.
Kinsley, T. P.
Kistler, Hiram W.
Klar, Henry W.
Klein, Otto B.
Kling, S. J.
Klingsberg, W.
Knight, Frank B.
Knight, W. J.
Knowles, J. H.
Knowlton, W. T.
Knox, Renwick B.
Kruttsehmitt, T. H.
Koenig, Arnold C.
Koerner, Carl A.
Koppel, Co., Artuur
Kotz, Harry A.
Kreer, John G.
Kreshaw, C. G.
Kreuger, J.
Krieschbaum, C. A.
Kuntz, S. T.
Kyle, Mathew L.
Kyle, R. B.

Lacy, Orlando
Laing, G. W.
Lamb, G. N.
Landor, Edward J.
Lane, F.
Lane, G. S.
Lane, J. Harold
Langley, C. E.
Langthorn, J. S.
Laurin, James
Lea, F. Z.
Lee, F. L.
Lee, R. H.
Leicester, A. R.
Le Fevre & Edwards.
Le Fevre, D. P.
Leonard, C. M.
Letson, T. H.
Levine, J. J.
Levy, Harold A.
Lewis, F. T.
Lewis, Myron H.
Lilly, A. J.
Lilly, J. A.
Lind, E. G.
Loewring, Reinhold
Logan Contracting Co.
Longley, A. C.
Longley, John E.
Look, M. J.
Loomis, Chester B.
Loomis, T. H.
Love, A. C.
Lowe, P. L.
Lowther, Burton
Loxterman, Howard B.
Lyon, F. W.
Lytle, Leonard

Macafee, S. B.
McAllister, Chas. H.
McAllister, P. T.
McBee, Echois
McCarthy, C. H.
McCarthy, Stearnes & Co.
McCarton, F. W.
McClintock, H. E.
McClure, W. F.
McCord, Jas. B.
McCormick, R. S.
McCoy, B. L.
McCullough, Ernest
McCurdy, J. F.
McDonald, A. W.
McDonald, W. N.
McGrath, M. P.
McGrew, J. A.
McGronan, Charles J.
McGuire, F. J.
McKay, Archibald
McKee, R. P.
McKiernan, S. G.
McKnight, James R.
McLane & Meyers.
McLeod, Norman M.
McMaster, A. T. C.
McMurty, Guy
McNeal, L. S.
McNeish, J. S.
Malcomson, A. S.
Macdonald, F. A.
Macdonald, Peter J.
Macdonald, W. A.
Mack, J. F.
Mack, W. W.
MacGregor, J. T.
Mackall, R. C.
Mafr, Geo. G.
Malcomson, A. Bell, Jr.
Malsbury, O. E.
Maney, J. J.
Manly, Frank

- Manley, Fred J.
Mann, J. L.
Markee, John E.
Marony, John A.
Marshall, H. L.
Marshall, Horace M.
Marston, W. S.
Martin, Chas. C.
Martin, W. F.
Marsh, M. M.
Marcellus, J. B.
Martin, F. O.
Martin, H. B.
May, E. C.
Mees, C. A.
Merritt, Fruman H.
Mersereau, C. V.
Metcalf, D. B.
Metropolitan Contracting Co.
Metzger, Louis C. F.
Meyer, Rudolph
Meyers, Wm. J.
Middleton, P. K.
Middleton, W. E.
Millard, Wm. J.
Miller, S. D.
Miller, Josiah
Miller, S. D.
Mills, Frank W.
Minshall, Frederic
Minto, Wm.
Mitchell, E. G.
Mitchell, Ernest H.
Mitchell, Roy C.
Moehel, Jean R.
Moeller Bros.
Monaghan, Edw. J.
Monohan, John J.
Montandon, H. L.
Monteith, Arthur D.
Mook, M. B.
Mool, Harry W.
Mooney & Sons, J.
Mooney, J. F.
Moore, A. R.
Moore, DeWitt V.
Moore, R. W.
Morre, Wm. S.
Moorshead, T. C.
Moran, H. P.
Morrill, George Pillsbury
Morris, Charles W., Jr.
Morrison, E. T.
Morrison, Henry C.
Morrison, Herbert H.
Morrow, H. A.
Morser, E. J.
Moskowitz, J. A.
Motz, T. B.
Mozart, William J.
Mullen, Luke D.
Mulville, John C.
Murphy, John Z.
Murphy, R. Lincoln
Murray, Charles T.
Murray, Chas. W.
- Nawn, H. P.
Neef, John H.
Nelson, George
Newman Sewer Construction Co.
Newton, George C.
Newton, G. J.
Newton, S. D.
Nicholas, G. H.
Nicholson, George
Nims, A. F.
Norcross, P. H.
Noyes, Arthur P.
Nusbickel, F. H.
- Oakes & Co., G. W.
O'Bannon, W. A.
O'Connor, James T.
Okey, Frank M.
O'Hern, Thos.
Olmstead, Henry, Jr.
Olmstead, H. G.
Olmstead, Herbert
Olmstead, Norman K.
Onelle, R. C.
Oxley, J. M.
- Packard, I. Rupert
Paget, R. E.
Palmer, John C.
Palmer, L. G.
Palmer, Miguel C.
Park, James C.
Parker, A. F.
Parker, G. A.
Parker, Jno. W.
Parker, O. K.
Parker, Thatcher A.
Parlin, Raymond W.
Parmlee, Chas. L.
Parsons, C. E.
Parson, J. L.
Patterson, Herbert S.
Patterson, Robert
Patterson Co., W. W.
Pearson, Frank C.
Peckinpaugh, C. L.
Pellerin, Francis V.
Pendleton, Geo. H.
Perdue, E. M.
Perkins, A. H.
Perkins, L. M.
Perrine, W. F.
Perry, Chas. E.
- Perry, Dwight
Peters, J. F.
Pfeiffer, Geo. W.
Phelps, W. W.
Phillips, J. B.
Pierce, Charles H.
Pike, Geo. B.
Pitt, E. D.
Plummer, Will F.
Pollak, Robert R.
Porter, H. P.
Postle & Waddingham
Powell, Norman S.
Powell, W. J.
Pratt, Edmund A.
Prendergast, E. F.
Price, F. E.
Price, John D.
Priest, E. B.
Pulford, C. H.
Pullen, K. A.
Purdy, James H.
- Quihnet, Chas. H.
Quilty, T. Frank
Quimby, C. H., Jr.
Quinn, Chas. W.
Quirk, E. McG.
- Rabitt, P. S.
Ralston, Clarence E.
Ramsden, C. H.
Raschbacher, H. G.
Rathjens, Geo.
Rauschenberg, O. C.
Rea, Richard W.
Reasoner, Richard B.
Reasoner, R. B.
Reece, O. T.
Reed, Howard S.
Reed, W. C.
Regan, D. P.
Reid, A. L.
Reid, Homer A.
Reid, J. G.
Renick, Seymour
Reuterdahl, Arvid
Reynolds, O. J.
Rhodes, William S.
Rhodin, C. J.
Rice, D. M.
Richards, J. B.
Richmond, Frank J.
Ricker, R. F.
Riddle, Thomas H.
Riker, N. D.
Riley, John D.
Rinearson, Abraham L.
Ripley, C. M.
Ripley, Thomas M.
Ririe, A. A.
Roberts, C. W.
Roberts, Frank
Roberts, Edward B.
Roberts, J. A.
Roberts, Vaughan M.
Robertson, Wm. E.
Robinson, E. J.
Robinson, Geo. Prentiss
Robinson, L. G.
Rockwell, W. L.
Roddey, John H.
Rogers, C. H.
Rogers, J. S.
Rollins, H. L.
Rollins, N. A.
Rollins, Ralph H.
Romaine, Henry F., Jr.
Rosborough, C. M.
Ross, E. S.
Rowe, W. A.
Rowe, Wilfred L.
Rowley, A. W.
Russell, R. L.
Russell, W. G.
Ryan, Laurence P.
Ryan, Richard R.
Ryan, Walter J.
- Saenger, George W.
Sager, N. A.
Saint Vincent, Wm. A.
Samuel, Geo. F.
Sample, William C.
Sanborn, John L.
Sanctuary, E. N.
Sener, C. C.
Sargent, Joseph A.
Saunders, Henry W.
Saunders, Penrose M.
Sayn, Albert I.
Scales, Geo. C.
Scammell, J. H.
Schantl, Hans
Schilling, A. H.
Schoch, John A.
Schoeiner, B.
Schroster, Tony
Scott, G. E.
Scott, Morse P.
Scribner, H. D.
Seabury, George T.
Seaver, J. W., Jr.
Sebold, R. P.
See, Thos. H.
Seedmann, Henry P.
Seelig, Ed. F.
Semon, Edward G.
Serber, D. C.
Severs, R. F.
Sharp, Thurlow R.
- Shaw, H. L.
Shaw, L. S.
Shaw, Walter A.
Shelly, Owin W.
Sheppard, John L., Jr.
Sherrill, Samuel S.
Shibley, Kenneth
Shinholser, Steve O.
Shipman, C. E.
Simmons, W. H.
Singleton, Thos. D., Jr.
Slagel, Franklin C.
Slater, W. A.
Slifer, Hiram J.
Slippy, James C.
Small, Wm.
Small, George E.
Smith, Alvin G.
Smith, F. A.
Smith, Godfrey L.
Smith, Layton F.
Smith, Lewis E.
Smith, M. W.
Smith, P. H.
Smith, W. G.
Smith, W. R.
Smyth, Raphael S.
Smythe, F. A.
Smythe, Wm. R.
Snell, L. J.
Snow, Geo. W.
Snow & Sherrill
Snowden, R. E.
Snyder, Frederic A.
Snyder, Hunter I.
Snyder, Ralph M.
Solomon, G. R.
Solomon, Julian M., Jr.
Solomon-Norcross Co.
Soner, C. C.
Soper, Fred C.
Soper, Ellis
Soper, T. C.
Sourby, John R.
Spencer, W. B.
Sprague, W.
Spruever, A. Reginald
Spuhler, H. A.
Staples, C. Bayard
Stauffer, O. E.
Stebbins, Gilbert R.
Steel, J. C.
Steele, Maurice E.
Steeles, Wm. C.
Steeves, C. McN.
Steffens, Charles J.
Stephens, F. W.
Stephens, H. Morton
Sterber, D. C.
Stevens, E. M.
Stewart, John
Stewart, J. M.
Stewart, Robert L.
Stickel, H. S.
Sticer, Jno. S.
Stilson, Horace T.
Stock, Harry
Stoddard, Edward B.
Stone, A. H.
Stone, Joseph H.
Stone, W. A.
Story, George
Stover, Weller E.
Strange, V. P.
Strassburger, L. W.
Street, Geo. G.
Strickler, G. B.
Strickler, T. J.
Surveyor, Arthur
Swan, G. C.
Swart, H. V.
Swartout, Wm. C.
Swett, Barton J.
Switzer, Vincent W.
Sydnor, L. W.
Symees, Whitman
- Tank, John T.
Tapley, A. G.
Tate, J. McLane
Taylor, Andrew, Jr.
Taylor, E. A.
Taylor, Fred C.
Taylor, Lincoln
Taylor, W. C.
Thomas, Edw. C.
Thomas, Jacob
Thompson, A. D.
Thompson, Chas. M.
Thompson, Edw. P.
Thompson, Robert M.
Thompson, William L.
Thorn, C. O.
Thornley, W. C.
Throop, A. T.
Tiffany, Nelson O.
Titus, J. H.
Topping, Howell
Trainer, David
Travell, W. B.
Tremper, W. L.
Triebel, Albert
Troutman, H. W.
Turner, A. M.
Turner, W. T.
Turney, Omar Ash
Tyngood, L. Scott
Tyssowski, J. G.
- Uhl, W. F.
- Uhler, Wm. D.
Ulmer, Joseph
Ulrich, Geo.
U. S. Wind Engine & Pump Co.
Unruh, D. S.
- Van Aiken, A. M.
Vahalle, J. Chas.
Varasdale, DeForest
Van Buren, C. J.
Vance, W. N.
Vandenberg, J. M.
Vandenberge, W. F.
Vandruft, R. E.
Van Liew, J. E.
Vansettart, G. E.
Vazey, V. S.
Vinton, J. R.
Vogt, Jno. H. L.
Von Borls, Wm. J.
- Wachter, Chas. L.
Wahlquist, Andrew
Walbridge, John T.
Waldo, W. B.
Waldron, Albert E.
Walker, Thos. H.
Wallace, Louis R.
Walter, C. D.
Waltman, W. D.
Ward, C. C.
Ward, Chas. Merrill
Wardall, F. C.
Warlow, A. Judson
Warner, C. R.
Warner, J. E.
Warner, Wm. H.
Warren, George
Warren, Wm. H.
Washburn, D. Cuyler
Weakland, F. L.
Weatherford, J. H.
Weaver, Frank M.
Webb, Henry
Webber, F. G.
Webster, Geo. H.
Weeden, George E.
Weeks, W. C.
Welse, Fred E.
Wemlinger, J. R.
Werlich, J. F.
Werner, W. Alfred
Wescotnith, T. A.
West, R. L.
Western Construction Co.
Wetherhill, Isaac
Wetherhill, Jas. P.
Wetzler, Wm. H.
Weymouth, Ralph W.
Wheeler, Edgar T.
Wheelock, D. F. A.
Whetsel, E. J.
Whipple, O. G.
Whitbeck, Albert T.
Whitecomb, Edwin B.
Whitecomb, R. N.
White, Byron E.
White, David M.
Whitehouse, L. M.
Whittier, C. C.
Whiting, F. H.
Whorley, W. M.
Wickes, Edward D.
Wiest, J.
Wigley, Chester
Wilbur, Harry
Wilcox, Frank L.
Wilcox, Frederick
Wiley, H. L.
Willard, Wm. J.
Williams, Chas. P.
Williams, W. H.
Wills, Arthur J.
Willis, M. H.
Wilson, Alfred B.
Wilson, Arthur R.
Wilson, E. A.
Wilson, H. Z.
Wilson, John H.
Wilson, John H.
Wiltsee, W. P.
Winchell, W. D.
Winslow, David H.
Winslow, O. C.
Winston, J. O.
Winters, Winston Lee
Wittmer, P. B.
Woermann, F. C.
Wolfe, Arthur J.
Wolford, J. Dan
Wood, Charles Lyon
Wood, Chas. M.
Wood, Warren
Woodward, J. F.
Woodsey, M.
Wright, Bert
Wright, James O.
Wright, Percy E.
- Yanger, A. E.
Yanger, A. J.
Yerger, H. C.
Yerza, E. D.
Young & Son, A. G.
Young, C. S.
Young, Ernest B.
Young, Harry A.
Young, James L.
Young, W. W.
- Zucco, Palmier

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Method and Cost of Constructing a Rubble Concrete Dam in the Central States.

This article describes the earthwork and concrete construction incident to a hydro-electric development in the middle west. Although neither the name of the contractor nor the locality of the work can be given, it will serve all statistical purposes to state that the work was located within 200 miles of Chicago in a small country town, whose population was made up almost entirely of those employed on the construction, but one whose railroad facilities were all that could be desired. The river is one of the upper tributaries of the Mississippi, draining over 1,200 square miles of densely wooded forest land, flowing through a series of broad marshes and swift rapids, deep cut in the narrow valleys, until it empties into the mother stream. At the chosen site there is an average depth of 6 ft. and flow of 600 cu. ft. per second, which will impound a reservoir with an area of 650 acres and a maximum depth of 50 ft., 10 ft. of which is available, as the river here narrows down from a wide marsh plain to a deep rocky channel, making an ideal spot for water storage.

The dam is a structure of cyclopean concrete, having a spillway of 400 ft., flanked on each side by abutments of the same material and earth dikes extending 1,500 and 2,800 ft. from each end. The dam itself has a maximum height of 19 ft. and a width of base of 19 ft., its section being of a standard "ogee" type. The earth dikes have an extreme height of 31 ft., side slopes of 2 to 1, 1 ft. berms, and are made impervious by concrete core walls founded on bedrock. These have a thickness of 2 ft. at the top and a batter of 12 on 1 on each side.

The preliminary construction work, consisting of the erection of a camp for the working force of 400 men and the clearing of the dam site, was commenced April 10, but it was not until the following June that the organization was complete and the work well under way, the first concrete being laid July 9. The actual work of harnessing the river was accomplished by building above the dam location a timber rock-filled cofferdam, 500x150 ft., with a maximum height of 16 ft., the natural bank forming one side, thereby diverting the water into the east half of the river channel and allowing the excavation to be carried in the dry to bedrock.

Concrete mixing plants were erected on

each side of the river, containing three No. 1 Ransome mixers. An excellent granite quarry was opened up on the east side of the river, where a crushing plant of considerable capacity was erected, the broken stone being carried from there to the bins of the mixing plants by construction trains of Western dump cars. Sand and gravel were obtained from a nearby borrow pit with drag scrapers, screened and brought to the bins in dump-car trains. Cement was kept in an adjacent storehouse and wheeled by hand to chutes immediately above the mixers. The mixture was in 1 cu. yd. batches in the proportions of 1—2½—5, using Atlas Portland cement. About 150 cu. yds. is the average daily output of each mixer. The concrete was delivered in 1 cu. yd. tipping buckets and placed in the forms by means of push cars and 5-ton, 60-ft. boom, guyed derricks, operated by Lidgerwood and American double-drum engines, which were the limiting factors in the daily progress. Plum stones up to 1 cu. yd. in volume were bedded in the concrete and formed about 25 per cent of its mass. Lifts of 3 to 8 ft., a day were secured, care being taken in filling the forms to complete a horizontal course over the whole surface. Successive lifts were bonded together by the use of large stones imbedded so as to project half way above the surface of the lower course and lock with the subsequent layer. The forms were built of 2-in. dressed pine planks, braced with 4x6-in. studding, spaced 3 ft. apart on centers and stiffened with 6x8-in. horizontal walling pieces attached every 4 ft. The forms were anchored with heavy iron wire, or ½-in. band iron, and were not interchangeable, being knocked down as each section was stripped, and rebuilt for the next.

The dam was constructed in alternate sections, 40 ft. long, bonded together with vertical keys, 3 ft. apart in the clear and terminating 2 ft. below the upper surface. Upon reaching the center, the end cofferdams were removed and rebuilt across the east channel, sending the water through five 10x10-ft. sluiceways left temporarily in the structure. The excavation was then pushed forward in the east channel, and on Dec. 3 the last bucket of concrete was placed in the closing sluices.

The earth dikes were filled with drag and wheel scrapers drawn by Missouri mules, the former being used for all hauls under 200 ft. The corewalls were first constructed on bedrock, the concrete being wheeled in barrows an average of 200 ft. from con-

struction train to forms. Care was taken to bring no unnecessary stress on the walls by maintaining the fill at equal heights on each side of the core. Clay puddle and rip-rap protect the sides from erosion.

The plant and construction costs were as follows:

Camp.—The camp consisted of the following buildings:

Building.	Floor Area, Sq. Ft.
8 dormitories for 285 men.....	15,000
2 mess halls for 80 men.....	3,000
3 individual shacks for 3 men.....	864
1 storehouse.....	1,136
1 machine shop.....	900
1 blacksmith shop.....	100

Total floor area.....21,000

The cost of constructing these buildings was as follows:

Item.	Cost
158,000 ft. B. M. of lumber at \$22.59.....	\$3,575
15 carpenters 48 days at \$3.....	2,160
30,000 sq. ft. tar paper at \$0.0225.....	675
Nails	145

Total\$6,555

Interest and depreciation.....\$5,500

The cost per square foot of building was as follows:

	Per Sq. Ft.	Per Cent.
Lumber	\$0.17	55
Labor	0.10	32
Roofing and hardware.....	0.04	13

Total\$0.31 100

The carpenter work cost \$13.70 per 1,000 ft. B. M.

Sand and Gravel.—The excavation and screening of the sand and gravel required the following plant: One screening plant, 6 wheel scrapers, 7 spans of mules and harnesses, 6 living tents, 2 mule tents, ¼ dinkey engine, 6 Western dump cars and ½ mile of track. The investment cost of the plant was \$11,500; the daily plant charge was as follows:

	Per Day.
Interest and depreciation, \$5,000.....	\$30.30
Coal for boiler.....	2.00
Coal for ¼ dinkey.....	0.50
Oil for engine.....	0.40
Oil for ¼ dinkey.....	0.10
Feed and care of mules.....	7.50

Total\$40.80

Broken Stone.—The plant for quarrying and crushing the broken stone was as follows: One No. 5 Austin crusher, 1 hoisting engine and boiler, 1 60-ft. derrick, 4 steam drills, 6 scale boxes, 1,200 ft. track, ¾ dinkey engine, 6 Western dump cars, 1 blacksmith's shop and 1 winch. The investment cost was \$13,000; the daily plant charges were as follows:

	Per Day.
Interest and depreciation, \$5,500.....	\$32.30
Coal for boilers.....	5.50
Coal for ¾ dinkey.....	1.00
Oil for engines.....	0.30
Oil for dinkey.....	0.20
Explosives	22.50

Total\$61.80

Mixing.—The mixing plant consisted of 2 mixing plants (3 No. 4 Ransome mixers), 3 cement trucks, 700 ft. of track with trestle, 2 cement houses, 1 sand chute and 2 sand cars. The investment cost of the plant was \$7,900; the daily plant charges were as follows:

Item.	Per Day.
Interest and depreciation, \$2,900.....	\$17.20
Coal	2.10
Oil	0.15

Total\$19.45

Placing.—The plant required for placing concrete was as follows: Six hoisting engines and boilers, 7 derricks, 9 tipping buckets, 800 ft. of track, 6 flat cars, 500 ft. of trestle, 1 dinkey, 4 Western dump cars, 15 wheelbarrows and 18 shovels. The investment cost was \$18,000 and the daily plant charge was as follows:

Item.	Per Day.
Interest and depreciation, \$5,600.....	\$31.75
Coal	5.00
Oil	1.00

Total\$37.75

Wages.—The wages paid labor were as follows:

Class.	Per Day.
Foremen	\$3.00 to \$5.00
Engineers	\$2.25 to \$3.50
Firemen	\$1.75 to \$2.75
Tagmen	\$2.00
Carpenters	\$2.00 to \$3.50
Rivermen	\$3.00
Electricians	\$3.00
Riggers	\$2.50 to \$3.50
Mechanics	\$2.75 to \$3.50
Cooks	\$2.00
Laborers	\$1.75 to \$2.25
Waterboys	\$1.50

Main Dam Concrete.—The cost in place of the 30,000 cu. yds. of concrete in the main dam inclusive of labor and plant charges was as follows:

Item.	No. Foremen.	No. La-borers.	No. Skilled La-borers.	Cost Per Cu. Yd.
Stone	3	8	6	\$1.26
Sand	1	2	10	0.46
Cement	..	..	..	2.31
Forms	3	25	1	0.62
Mixing	4	3	32	0.58
Placing	3	6	46	0.69

Total\$5.92

Referring to the forms, the cost of material per foot board measure was:

Item.	Per Ft. B. M.
Lumber at \$28 per M.....	\$0.022
Nails	0.001
Wire	0.005

Total\$0.028

The forms were used three times and the average cost of forms per square foot of surface covered was 24 cts.

Concrete Corewall, East Dike.—This corewall averaged 11.2 ft. in height and took 78 days, including Sundays and idle

days, to build with a force of 5 foremen, 10 skilled laborers and 80 laborers. Sectional forms 4x12 ft. of 1 in. boards and 2x6-in. studding, were used. The concrete was delivered to trestle running 1,000 ft. by train. The cost of the corewall was as follows:

Item.	Total.
3,350 bbls. cement at \$2.31.....	\$ 6,675
961 cu. yds. sand and gravel at 75 cts.	725
1,928 cu. yds. broken stone at \$1.08....	2,082
Mixing concrete (2,893 cu. yds. at 42 cts.).....	1,215
Placing concrete (2,893 cu. yds. at \$1.01)	2,917
22,400 sq. ft. forms at 43 cts.....	1,232

Total\$11,876
1,450 cu. yds. excavation at 98 cts.... 1,424

Grand total.....\$16,300

The cost per cubic yard of concrete work proper was thus \$5.14 and the cost including excavation was \$5.66 per cu. yd.

Earthwork.—The cost of the earthwork in the dikes was as follows:

East dike: Volume, 21,900 cu. yds., sandy loam; force, 2 foremen, 44 laborers, 60 mules; lead, 600 ft.; plant, No. 2 wheel scrapers; unit cost, 28 cts. per cu. yd.

West dike: 8,900 cu. yds., sandy loam; force, 1 foreman, 14 laborers, 20 mules; lead, 60 ft.; plant, drag scrapers; unit cost, 26 cts. per cu. yd.

Method of Welding Reinforcing Rods for a Concrete Aqueduct by the Thermit Process.

In constructing the reinforced concrete test siphons at Peekskill, N. Y., for the New York water supply the thermit process was used to weld the circumferential reinforcing rings. The work is described as follows in a pamphlet published by the Goldschmidt Thermit Co., New York.

These siphons are 11 ft. inside diameter and are constructed of concrete, reinforced with steel rings formed of twisted rods bent in the form of a circle with the ends welded together. Two forms of reinforcement were used, as shown by the drawings. In Fig. 1 two rows of 1x1-in. rings were inserted at longitudinal centers of 4 ins. Figure 2 shows a single row of 1½x1½-in. rings on the same centers.

The contract covering the joining together of the ends of these rods called for a joint efficiency of 75 per cent., but as the material was high carbon steel with a tensile strength of 70,000 lbs., it was found impossible to obtain such a high efficiency by any method until the Thermit process was called upon. This process was finally adopted after a number of test welds had been made and subjected to tensile tests which in most cases proved an efficiency equal to the rod itself.

The method of procedure used in the field was rather crude, owing to the short space of time allowed for preparation, but it proved sufficient to keep well in ad-

vance of the construction work. The method employed was as follows:

The rods, after being cut to the proper length, were bent around a wooden form, allowing ½ in. between butt ends. The ends were then brought to a bright red heat in a forge and a set of flour and sand

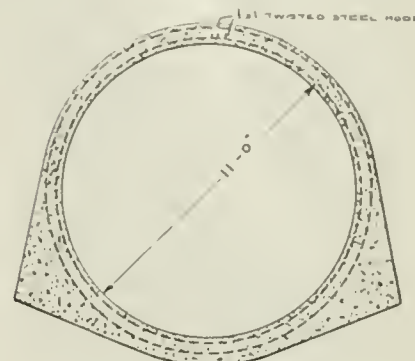


Fig. 1.

molds, baked in two parts ready for use, clamped around them. In the meantime an automatic crucible containing the proper quantity of Thermit was placed in position, and as soon as the molds had been made ready the Thermit in the crucible was ignited and the Thermit steel poured about the ends of the rods. It will be noted that this procedure differs considerably from the method in use for butt-welding rods, where the slag is poured into the mold first and serves to bring the ends of the rod to welding heat, at which time they are drawn together by clamps to ef-

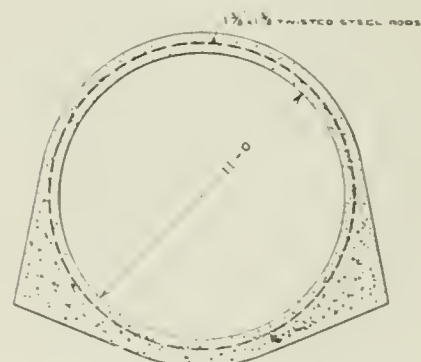


Fig. 2.

fect a weld. On the Aqueduct, however, a butt-weld would not have fulfilled the conditions of test, owing to the fact that it would have been impossible to leave a reinforcement of Thermit steel around the weld. By the method adopted it was possible to leave a considerable reinforcement, which added very greatly to the strength of the joint and contributed in a marked degree to the success with which the process was used on the work.

Aberdeen, Scotland is considering securing a new water supply. Its engineers have recommended a supply from the river Avon and estimate the cost of obtaining it at \$7,500,000.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Methods and Costs of Building Earthen Dikes on the Belle Fourche Project and Comments on Spreading Earth.

The Belle Fourche project contemplates the diversion of the waters of the Belle Fourche River at a point below the mouth of Redwater River and the storage of the same in a reservoir, to be formed by a dam across Owl Creek near the mouth of Dry Creek, about 10 miles northeast of Belle Fourche, S. Dak. This project will supply water to about 100,000 acres of land. The height of the dam will be 115 ft. and the length along the top will be 6,200 ft. There are to be 100 miles of distributing canals and 12 miles of laterals. There is also to be a concrete diversion dam. The excavation work on the main canal was described in our issue of March, 1906.

The contract for the dam was let to Orman & Crook, Nov. 14, 1905. Work was commenced at once. A few months ago this contracting firm made an assignment, and their contract has been taken over by the government. It is our purpose to give the methods and cost of the work done by the contractor.

Cost Keeping.—The U. S. Reclamation Service has a cost keeping system that is applied to all work, whether done by contractors or by the Service. Carefully detailed records are kept, and monthly reports are made to the Director of the Service at Washington. To insure the prompt and accurate record of data, the work is placed in the hands of a force of accountants, under the general direction of an expert cost keeper, who is called "Chief Fiscal Agent," and who is held responsible for the work of this department. This has been found necessary as engineers seem prone to neglect such work for matters more important until accurate records become impossible. Every bill paid must be charged to some structure or structures, and distributed to the proper details of the work; time keepers furnish daily reports on card forms, of the men employed, their wages and the kind of work as well as the structure. In this way records are kept of every item of cost in every piece of work.

Materials.—Borings and test pits at the dam site show that the material is homogeneous and compact. An analysis of the earth to be used in the dam was made, and from this the location of the borrow pits determined. The material is an adobe clay,

very sticky and boggy when saturated, but bakes very hard when dry, and it is hard to plow. There are occasional layers of sand and shale and scattering cobble stones. The clay is readily compacted and is nearly impervious to water.

The dam is built in 6 in. layers and all stones larger than 6 ins. in diameter are excluded. Neither a core or puddle wall is used in the embankment or dike. There are to be 1,580,000 cu. yds. in the finished embankment.

Local Conditions.—The fact that Owl Creek runs dry in summer made it necessary for the contractor to store water for use in compacting the earth. A reservoir was built, at his own expense, at each end of the dam. Into these reservoirs water was pumped from the creek during the rainy period. The rate of evaporation being high, much more water than actually needed for compacting has had to be stored. The sprinkling is done with hose connected on the elaborate system of pipes, laid on top of the dam. When there is water in the creek the water is pumped directly into the system of pipes but when the creek is dry the reserved supply in the reservoirs is used. Any leaks in the pipes cause troublesome bogs, as the adobe clay absorbs water quickly. On the other hand, when dry, it pulverizes easily, thus causing great clouds of dust on windy days. Although the work is not interfered with on account of rain, it has to be suspended during these wind storms, as neither man nor beast can stand the dust. This dust so affects horses and mules employed on the reclamation service that many of them get a lung trouble from which they quickly die. The aridity increases the cost of sprinkling.

Another condition that affects the cost of the work is that the surface water is so bad for boilers that the contractor has been compelled to put down two artesian wells each 1,430 ft., to supply water for his steam shovels, locomotives, traction engines, rollers, etc. For about four months in the year the work on the earthen dikes has to be shut down, owing to the cold weather, as the material would freeze in the embankment. All trench excavation, excavation for structures, for stripping borrow and gravel pits, and for trimming embankments, are according to the specifications paid for extra.

Amount of Work.—The costs given below include the cost of the work done by the contractor during the years 1906 and 1907, a total of 504,000 cu. yds. Two methods were used in this work: one being steam shovels and trains, moving 305,000

cu. yds.; while the other was by elevating graders and wagons, excavating 199,000 cu. yds. In 1906 one steam shovel was used, while in 1907 two shovels were worked.

Cost of Outfit.—The outfit and the value of it used on the work was as follows:

2 75-ton Vulcan steam shovels....	\$22,000
6 18-ton Davenport dinkeys, at \$3,100	18,600
40 Western 4-yd. dump cars, at \$230.	9,200
2 Standard Western graders, at \$1,200	2,400
4 32 Hp. 21-ton traction engines, at \$3,500	14,000
1 12-ton Kelly Springfield roller..	2,500
4 Miles of track complete.....	16,000
2 6-horse road machine, \$225.....	450
24 1½-yd. Aurora wagons, \$120....	2,880
15 Buck scrapers, \$17.50.....	263
Pumps, pipe, camp, miscellaneous tools, etc. (estimated).....	11,707
Total	\$100,000

This is the plant that was on the work at the end of 1907, but not much more than half of it was the average on the work during 1906; hence, if we figure interest, depreciation and repairs at 2 per cent per month, we have \$12,000 for 1906 and \$24,000 for 1907, or a total of \$36,000 for the two years.

Steam Shovel Work.—The method of carrying on the steam shovel work was as follows: Two 75 ton Vulcan steam shovels equipped with 2½ cu. yd. dippers loaded dirt into 4 cu. yd. Western dump cars. A train of 10 cars, were pulled on 3-ft. gage tracks by 18-ton Davenport dinkeys. Two dinkeys pulled the trains for each shovel and an extra dinkey spotted cars. The cars hauled 3.1 cu. yds. place measurement, as determined by 100,000 loads. During 1906, the material was hauled an average distance of 1 mile against a 2 per cent grade, while in 1907 the 1 mile haul was all down grade, the maximum grade being 4 per cent.

The tracks on the embankments were so arranged that earth was spread on them 50 ft. each way from the track. The layers were made 6 ins. deep. As the dumping of the whole train of 10 cars at one time, would result in the earth blocking the movement of the cars, only alternate cars were dumped, and then the train was pulled ahead a train length and the other five cars dumped. As the cars when coupled measured 13 ft., center to center, this meant a pile of earth containing 3.1 cu. yds. every 26 ft. Each pile spread made about 168 sq. ft. of embankment 6 ins. thick. The idea of dumping alternate cars is excellent on embankments of this character, or even in widening railroad embankments as it makes the spreading of the material easier.

At first the attempt was made to spread these piles of earth with a Western Embankment Spreader, but the dinkeys were not powerful enough to handle the spreader against the piles of earth. This spreader will spread the earth about 7 ft. from the

rail, so, if it had worked successfully, the area it could cover would have been enough to spread out the pile of earth to a thickness of 6 ins.

Six-horse road machines were then tried, but they, too, proved a failure when used alone. The reason for this was that the material when excavated by the steam shovel came out at times in large clods or lumps, and these lumps tossed the machine around as the waves of the sea do a small boat. Recourse was then had to buck scrapers to do the preliminary spreading. These pulled by horses spread the earth out roughly for a distance of 50 ft. on each side of the track, the road machine finishing off the layers. Three layers were thus spread before the track was shifted into a new position, 10 ft. from its old place.

The sprinkling was done from the system of pipes run over the reservoir dike.

The rolling was done by a 32 H. P., 21-ton traction engine and a 12-ton Kelly Springfield road roller. The great weight of the engine no doubt was an assistance in compacting, but unless the tread of the driving wheels of the engine were wider than the standard, the area compacted by one trip of the engine could not compare to that of the roller. This would increase the cost of the rolling over using a roller of the same weight.

Wages.—A 10-hr. day was worked by the contractor, and, owing to the great amount of construction work going on in all parts of the country at that time, the labor was very indifferent. The shovel men and train crews were paid standard wages, while the laborers were paid at the rate of \$2.25 to \$2.50 per day. Horses were paid for at the rate of \$1.15 per day. This cost covers the care and feed of the horse, likewise the interest and depreciation on the animal, and explains why horses are not listed under the head of outfit. Coal cost delivered on the work \$10.50 per ton, 40 per cent dynamite by the car load, 12¼ cts., and black blasting powder \$1.20 per keg.

Cost of Work.—The cost of the work, consisting of the total pay rolls, the cost of supplies and estimated interest, depreciation and repairs was as follows:

Labor	\$71,163.44
Supplies	22,827.08
Interest, depreciation and repairs (estimated)	30,000.00
Total	\$123,990.52

This cost includes, superintendence, camp expense, general expense, and, in fact, all direct and indirect cost of doing the work. The overhead charges were about 10 per cent of the total cost. This cost is distributed over the unit costs given below.

The steam shovels excavated per day an average of 951 cu. yds., which is an excellent record to maintain for so long a period. The cost of supplying the water for engines and sprinkling has been included in the items given and in the unit costs

given below, has been properly distributed. The cost per cu. yd. was as follows:

Excavation:	
Labor	\$0.017
Supplies	0.021
Total excavation.....	\$0.071
Hauling:	
Labor on train	\$0.037
Labor on track	0.012
Supplies	0.035
Total hauling	\$0.084
Spreading:	
Labor	0.118
Rolling:	
Labor	\$0.006
Supplies	0.007
Total spreading	\$0.013
Sprinkling:	
Labor	\$0.014
Supplies	0.004
Total sprinkling	\$0.018
Plant:	
Int., deprec. and repairs (estimated)	0.098
Grand total	\$0.405

Spreading Earth.—This is a high cost for earth excavation of this class, even under the adverse conditions under which the work has been done. This cost is among the highest for earthen embankments for reservoirs so far built by the Reclamation service. The high price of coal has added to the cost of loading, hauling and compacting, but a glance at the unit cost shows that the spreading of the earth on the embankment was too costly. One of the high officials of the Reclamation Service stated that the contractors on this work lost money, having been hampered by a shortage of funds and inefficient superintendents. The contract price for the embankment was 28 cts. per cu. yd. so about 12 cts. per cu. yd. was lost on this part of the work. The spreading cost about 12 cts. It should have been evident to any one that such a cost was ruinous, as this work on reservoir construction seldom costs more than 2 cts. per cu. yd.

On the upper Deer Flat embankment, on the Payette-Boise project, an embankment of about 1,000,000 cu. yds. is being built with cars and steam shovels and the cost is less than 2 cts. per yd. for spreading. Here the track is moved away from the earth, after the cars are dumped, with teams of heavy horses, when road machines do the spreading, two machines spreading about 300 cu. yds. per hour. The track lies flat on the ground, and is well spiked to 6x8 ties. It stands the rough usage very well. The total cost for this spreading work up to 1908, was 1.9 cts. per cu. yd. although in some months the cost had been as low as 1.4 cts.

It is true that at the Upper Deer Flat embankment, the earth was free from large

clods, but even if the clods that hampered the work at Belle Fourche had been broken up by men with sledges or mauls, so as to make it possible for the road machines to do the spreading, the extra cost for breaking the clods would not have amounted to more than a cent or two per cu. yd., and it would have been less than that had they used a spiked disc harrow such as the Petrolithic Pavement Co. has found so efficient in pulverizing baked adobe clods encountered in some of their road work. It is certain that it would have been far less than the 10 cts. that it did cost by the method of spreading with buck scrapers described above.

There is also little doubt that the Western Embankment Spreader would have done the work of spreading, if given some assistance. Two or three dinkies attached to it would have given ample power to propel it, and, if the spreader had been properly weighted down, there is little doubt that it would have cut up the clods. These track spreaders have been used with great success on railroad embankments, but at times extra locomotives have been used on them and where rock occurs or large lumps of earth, it is always necessary to add weight to the car body; even then it sometimes pays to have some of the largest lumps of earth broken up by hand, or to remove some of the largest pieces of rock. This can frequently be done by the dump crew without extra cost. The extra locomotive and crew, or even two of them, would have only added slightly to the cost.

It is rather a singular thing regarding men employed on construction work that, if a machine or tool does not work in the manner it was expected to work, or is not altogether successful, they seldom experiment with it to see what is needed to make it work satisfactorily, but, instead, throw it aside and adopt some other method, even though that method may be much more expensive. Numerous examples of this sort of action could be given. It seems to have been the case at the Belle Fourche dam. A saving of 9 or 10 cts. per cu. yd. on this one item might have saved the contractors from financial ruin on this job, as the grader work was done at a small profit, as were some other items of the contract.

Then, too, it is reasonable to suppose that if bad judgment was displayed in doing this one item of the work, it may have also been displayed on other parts of the work.

Elevating Grader Work.—Two Western Standard elevating graders were used on the work, propelled either by 16 horses or 21-ton traction engines. As a rule the engine is the cheaper method. These graders loaded Aurora dump wagons, having a capacity of 1½ cu. yds. The load, place measurement, actually carried was 1.1 cu. yds., as derived from a record of 100,000 loads. Three horses were used on these wagons, 21 wagons being used to serve the two graders, the average haul being about 1,300 ft. The use of three horses to a

wagon is to be commended. The extra cost is entirely in the horse, which in this case amounted to \$1.15 per day, and the larger load carried with the other expenses of the work fixed, means that the extra cost of the horse is soon paid. With only 2 horses, either the load would not have been as large or the number of trips would have been reduced, or both smaller loads would have been hauled and less of them. As it was, each wagon averaged about 42 trips per day, traveling a distance over the lead of about 10 miles. Considering the distance covered in following the grader and in turning, no doubt the total distance traveled per day would equal 15 miles.

The elevating grader, to a great extent, pulverizes the earth as it excavates it, hence in spreading no trouble was experienced with clods or lumps. This allowed the road machine to do the spreading without assistance, which confirms our statement that some form of clod breaker would have easily solved the problem of disposing of the clods that came from the steam shovel work. The sprinkling and rolling was done as described under steam shovel work.

The wages paid for men and horses are given above, also the cost of coal and other supplies.

The Cost of Grader Work.—The total cost of the elevating grader work was:

Labor	\$41,530.92
Supplies	4,468.24
Interest, depreciation and repairs (estimated)	6,000.00
Total	\$51,999.12

This includes all costs, direct and indirect. The superintendence and overhead charges were about 12 per cent of the total. Each grader loaded 556 cu. yds. per day. The road machine spread about 150 cu. yds. per hour.

The cost per cu. yd. of the grader work was as follows:

Excavating:	
Labor	\$0.047
Supplies	0.012
Total excavating	\$0.059
Hauling:	
Labor	0.126
Spreading:	
Labor	0.016
Rolling:	
Labor	\$0.008
Supplies	0.008
Total rolling	0.016
Sprinkling:	
Labor	\$0.011
Supplies	0.003
Total sprinkling	0.014
Plant:	
Interest, depreciation and repairs (estimated)	0.030
Grand total	\$0.261

It will be noticed that the spreading in this case cost 1.6 cts. The wagons deposited the loads 9 ft. apart in windrows 7 ft. apart, and the road machine spread it from these piles. This is real spreading, while in the case of the steam shovels the "spreading" consisted first of rehandling and then spreading. It is possible to spread earth very evenly with buck scrapers, so that no other work on it is necessary.

We are indebted to officials of the Reclamation Service for the data upon which this article is based, excepting the data relating to plant interest, depreciation and repairs.

As stated in this article, the contractors failed, and the Reclamation Service has taken over the work. This being a losing job, and the fact that they were sustaining losses on other contracts they held, if reports are true, no doubt made them short of funds, but there is another reason for their failure, namely the changing of the working day from 10 hrs. to 8 hrs. When the contractors took this work they worked 10 hrs., as was being done by most contractors on government work, and this continued for two years when the contractors were compelled to come to an 8 hr. day. This naturally added 20 per cent to the cost of the work, thus compelling the contractors to "throw up the sponge." This is an injustice that is frequently done to contractors, either by enforcing an old law in the middle of the execution of a contract, or by passing a new law that becomes operative at once. When a new law goes into effect before existing contracts can be completed, it is, theoretically, not retractive. Practically it is, for the workmen strike for its immediate application, regardless of the disaster that they thus bring upon an innocent contractor.

The sixteenth National Irrigation Congress, held at Albuquerque, N. Mex., closed Oct. 3. The 1909 convention will be held at Spokane, Wash. The following officers were elected at the convention just closed: President, George I. Barstow of Texas; vice-president, H. D. Loveland, San Francisco; second vice-president, I. D. O'Donald of Montana; secretary, B. A. Fowler of Arizona. The meeting was very successful both in point of attendance and showing of reclamation work.

The National Conservation Commission has started work on a census of the standing timber of the United States. The commission aims to secure the necessary information by correspondence and for that purpose has sent out nearly 150,000 letters. This is the first comprehensive attempt at a forest census ever undertaken in the United States. The most carefully prepared estimates yet made on the amount of standing timber in the United States place the total stumpage at 1,390 billion board feet. This estimate was made by Mr. Henry Gannett and published by the 12th census in 1900.

The Cost of Excavating Earth in Small Quantities with a Steam Shovel.

Steam shovels are used for excavating earth in large quantities, and where so used are generally considered economical; but it has been the prevalent impression among dirt movers that, when the amount of material to be moved in a day is small, some other method than the steam shovel should be used, as the outfit is too expensive for small quantities, and the daily operation is too costly. This may have been true some years ago, but, during the past decade, shovel manufacturers have developed a small type of shovel for this class of work that has proved to be economical, and the use of such shovels on construction work and for purposes of mining or mine stripping is rapidly increasing. In this article we are able to give the record and cost of excavating with such a shovel.

The amount moved daily in this case was less than 100 cu. yds. The shovel used was the revolving type, No. 1, manufactured by the Vulcan Steam Shovel Co., of Toledo, Ohio. This shovel weighs about 28 tons, and is sold for \$5,000. The shovel was mounted on a single standard railroad truck. It will revolve through an angle of 360°. This allows the shovel to dig and dump the earth on all sides at any point within reach of the shovel. The radius of dump from center to turntable is 28 ft. The clear lift of the dipper with the door open is 9 ft., while the height of the boom above the rail is 16 ft. The car and boom are built of structural steel. It has 7x6 in. hoisting engines, and 5x6 in. duplex reversible swinging engine. The boiler is of the vertical type, 7 ft. 6 in. high and 46 ins. in diameter. The working steam pressure is 125 lbs. There are two steel water tanks of 200 gals. capacity each and a steel coal bunker holding 500 lbs. of coal. The shovel is self propelling. The dipper is of ¾ cu. yd. capacity. The dipper handle is made of selected timber. These revolving shovels are made in four sizes with dipper capacity varying from ½ cu. yd. to 1½ cu. yds.

The shovel in question was worked in a clay pit, digging clay for the manufacturing of bricks. The shovel was called upon to dig only 80 cu. yds. per day. For this outfit only one man operates the machine, and he fires, acts as engineer and trips the bucket door. The shovel loaded one ¾ yd. dump car, manufactured by the Atlas Car & Mfg. Co., of Cleveland, Ohio. This car was pulled to the brick yard by a horse driven by a boy, an average distance of 700 ft. The shovel loaded a second car while the first was being hauled to the brick yard.

The shovel worked 10 hrs. and used 600 lbs. of coal per day. Water was furnished for the shovel from a tank that supplied the brick yard at a cost of about 7 cts. per day. One man was used to keep the track

in condition and to clean up behind the shovel and around the cars.

The total value of the outfit including cars is a little over \$5,100, and, allowing 18 per cent per season for interest, depreciation and repairs, with 200 working days in a season, gives a daily allowance for plant of \$1.60 per day.

The daily cost for the 80 cu. yds. excavated was as follows:

Engineer	\$ 2.25
Extra man.....	1.75
Horse and boy.....	2.22
Oil, waste and water.....	.27
600 lbs. coal at \$2.60 per ton.....	.78
Interest, depreciation and repairs (estimated)	4.60

Total\$11.87

This gives a unit cost as follows:

Loading	\$0.028
Extra work.....	0.022
Hauling	0.028
Supplies	0.013
Plant charges.....	0.057

Total\$0.148

Considering the force of the plant and the wages paid, this cost is very low for such a small output.

The shovel was bought and installed in 1908. During the season of 1907 the excavation in the clay pit was done by hand, the cars of clay being pulled by a horse as with the steam shovel. The cost of this work was \$14.43 per day. This was a unit cost of 18 cts. per cu. yd.

It will be seen from this that the actual saving of the season of 1908 over 1907 was about 3 cts. per cu. yd. This effects a saving of about \$500 per year, and besides this the clay is better mixed than when worked by hand. Inasmuch as the pay roll is reduced, a saving is effected on employees' liability insurance, and there are less men to look after. For about the same cost a greater yardage could be excavated, but, as above stated, there was only needed 80 cu. yds. The shovel of course is capable of excavating a much larger amount of material, it served by a greater number of cars. When running at its maximum speed, however, it is advisable to increase the number of men over those worked in this case.

We are indebted to Mr. Wm. J. Spear of Toledo, Ohio, contractor, builder and brick manufacturer, for information contained in this article. Mr. Spear states that the shovel is quick acting and that he would not do without the machine in the manufacture of brick, as it has been a money saver.

The estimated cost of the Government railways in Chile, under construction, and for which contracts are about to be let, reaches \$65,627,000 gold. It is intended that all these lines shall be completed within the next five years.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Methods and Cost of Constructing Tar-Macadam, Tar-Pitch-Macadam and Tar-Asphalt-Macadam Roads in Rhode Island.

In our issue of March 25, 1908, we printed a paper by Mr. Arthur H. Blanchard, Assistant Engineer State Board of Public Roads of Rhode Island, descriptive of experiments that had been made in Rhode Island in 1906-07 on the treatment of roads with tar and oil. These experiments were continued in 1907-08 by the State Board of Public Roads and in a discussion on "The Maintenance of Macadam and Other Roads"* at the annual convention of the American Society of Civil Engineers, on June 25, Mr. Blanchard gave further particulars as to the experimental work. The matter that follows has been taken from Mr. Blanchard's discussion.

In the fall of 1906 a section of tar-macadam, 350 ft. in length, was built in Charlestown, the location being on a curve of the interstate trunk line connecting New York, Narragansett Pier, Providence, and Boston. With the exception of the addition of the tar, the method of construction was similar to that used in building an ordinary macadam road. After the sub-grade had been thoroughly rolled, the No. 1 broken stone, varying in size from 1 1/4 to 2 1/2 in. in longest dimension, was spread to a depth of 6 in. and rolled to 4 in. Tar which had been heated to the boiling point in an ordinary tar kettle, was then sprinkled on the rolled surface by using dippers. The No. 2 stone, varying in size from 1/2 in. to 1 1/4 in. in longest dimension, was next deposited on dumping boards and thoroughly mixed with hot tar by using rakes and shovels until every stone was completely coated. This mixture was applied on the No. 1 course to a depth of 3 in. and, after the tar had set, was rolled to 2 in. A thin coat of dust, which would pass through a 1/2-in. mesh was then spread on the surface and forced by rolling into the No. 2 course to fill up the voids and provide a smooth surface. The quantity of tar used was 1.25 gallons per square yard. As this stretch of tar-macadam proved efficacious, it was deemed advisable, in 1907, to construct an experimental mile, this section being on the same interstate trunk line as the curve just mentioned. Although it will require from 5 to 10 years to determine the economical status and the efficiency of the tar-macadam road constructed by the

method outlined, the perfect state of the surface of the 1906 and 1907 sections in the spring of 1908 influenced the state engineers to advocate the adoption of this method of construction on highways of the first class subjected to excessive motor-car traffic.

The sections thus far constructed for in 1908 include: First, two sections aggregating 11,300 ft., 11 ft. in width, on the interstate trunk line between Saunders-town and Narragansett Pier, which is subjected to all the motor-car traffic between the Pier and Newport, Providence and Boston, and the heavy touring-car traffic between New York city and Newport; and second, 11,870 ft., averaging 23 ft. in width, on an interstate trunk line in East Providence, which is subjected to a heavy motor-car traffic and also an abnormal commercial traffic. On one of the sections in the district of Narragansett the state engineers experimented with various bituminous mixtures used in different methods of construction, the object being to determine the most efficient binder and the most economical method of construction which would be adaptable to modern traffic. The original plan was to build, by each method, a 300-ft. section, 11 ft. in width, but the impracticability of certain methods with the tools at hand necessitated a modification of this plan. The experimental work was started after 1,300 ft. of tar-macadam had been constructed in accordance with the method used in 1906 and 1907. Table I is a descriptive statement of the various sections.

The roadbed selected for the experimental work was on a long tangent, the sub-grade being uniformly built on a 1-ft. fill, and the grade only varying from a minimum of 0.8 per cent to a maximum of 0.76 per cent. The broken stone used was of the same character throughout, consisting of local stone composed of a fine-grained granite and hornblende schist of the same size as that used on the 1906 and 1907 sections. The experimental work was all done in the month of May. The temperature while the work was in progress varied from 60° to 90° the average being 70 degrees. The tar used was produced at the Providence Gas Works, and cost, f. o. b. Providence, \$2.75 per barrel. The freight from Providence to South Ferry, a distance of 26 miles, distributed over three lines, was \$0.62 per barrel. The cost of the haul from the South Ferry station to the road, averaging 2,000 ft., was \$0.13 per barrel. The barrels cost \$0.75 each, which, minus the haul the freight to

*Proceedings American Society of Civil Engineers, August, 1908; p. 681.

Providence, would be refunded by the gas company upon return of the barrels. The net rebate was \$0.56 per barrel. The total cost of the tar, therefore, was \$3.70 per barrel.

The coal-tar produced at the Providence Gas Works is characteristic of gas-house coal-tars produced elsewhere, in that the percentage of water, ammoniacal liquor, light volatile oils and heavy oils is a variable quantity. In order to determine various facts, including the range of variation, samples, taken directly from the tanks at the gas works at various times, were analyzed. Table II shows the important results of the analyses. The percentage of volatile matter at 120° after heating from 6 to 8 hours represents the percentage which might be lost from the tarred surface of a road during summer seasons. The results in the column headed "Solid matter, in grains per gallon," were obtained by digesting a portion of the sample with an equal volume of water. The object of this analysis was to determine the quantity of matter which might be washed from the surface of a road by a heavy rain. The average specific gravity of the tar was about 1.26.

TABLE II.—COAL-TAR ANALYSES.

Date.	Percentage of volatile matter at 120° degrees.	Percentage of volatile matter at 260° degrees.	Solid matter, in grains per gallon.
Nov. 20, 1907.....	10.6	30.7	46.7
Nov. 27, 1907.....	6.8	27.9	102.2
Dec. 18, 1907.....	11.1	24.9	105.1
Dec. 24, 1907.....	7.1	21.3	20.4
Jan. 14, 1908.....	16.3	32.3	52.5
Jan. 21, 1908.....	7.2	19.4	5.8
Feb. 19, 1908.....	5.8	16.2	2.9
Feb. 26, 1908.....	4.7	15.3	8.5
Mar. 18, 1908.....	3.1	13.3	2.3
Mar. 24, 1908.....	3.9	18.1	33.2
Apr. 22, 1908.....	18.4	29.9	116.4
Apr. 29, 1908.....	8.0	19.0	5.8
May 20, 1908.....	7.9	20.6	...
May 27, 1908.....	8.1	23.3	...

In order to determine the time required to drive off a sufficient percentage of the light volatile constituents to render the tar satisfactory for road work, a sample of the tar was heated for certain definite periods, the result of which was as follows:

	Loss at 120° after heating ½ hr.	Loss at 120° after heating 1 hr.	Loss at 120° after heating 2 hr.	Loss at 120° after heating 3 hr.	Loss at 120° after heating 4 hr.	Loss at 120° after heating 5 hr.	Loss at 120° after heating 6 hr.
Additional Loss at 120° after heating ½ hr.	3.6	4.8	5.7	6.4	7.1	7.6	8.1
Additional Loss at 120° after heating 1 hr.	1.2	0.9	0.7	0.7	0.5	0.5	
Additional Loss at 120° after heating 2 hr.		0.7	0.7	0.5	0.5		
Additional Loss at 120° after heating 3 hr.			0.7	0.5			
Additional Loss at 120° after heating 4 hr.				0.5			
Additional Loss at 120° after heating 5 hr.					0.5		
Additional Loss at 120° after heating 6 hr.						0.5	

As many failures of tar-macadam have resulted from the use of tar containing a large percentage of light volatile constituents, the state engineers, taking into consideration the foregoing analysis, have decided to require that all tar, before appli-

cation, be heated for 2 hours at a temperature of not less than 150° F., the maximum quantity of tar heated in a 100 gallon kettle to be 50 gallons. It will also be required that all water shall be removed from the surface of the tar in the

miles, over three lines, was \$1.26 per barrel. The barrels, cost \$0.75 each. The rebate allowed was \$0.65, which, minus the cost of haul, and return freight of \$0.30 per barrel, made a net rebate of \$0.35 per barrel. The cost of the haul to the road,

TABLE 1.

No. of Section.	Length, in feet.	Material.	Method, etc.
1	300	Tar-macadam.	Mixing method, with tar omitted from surface of No. 1 course.
2	300	Tar-macadam.	Penetration method.
3	100	Tar-macadam.	Gladwell system.
4	300	Tar-macadam.	Mixing method.
5	130	Tar-pitch-macadam.	Mixing method, with chips added to No. 2 mixture.
6	70	Tar-pitch-macadam.	Mixing method.
7	300	Tar-macadam.	Mixing method.
8	300	Tar-asphalt-macadam.	Mixing method.
9	290	Tar-asphalt-macadam.	Mixing method, with bituminous mixture omitted from No. 1 course.
10	75	Asphalt-macadam.	Mixing method.
11	135	Tar-asphalt-macadam.	Mixing method, without bituminous mixture on surface of No. 1 course.
12	410	Tar-asphalt-macadam.	Mixing method.
13	190	Tarvia-macadam.	Mixing method.
14	172	Tarvia-macadam.	Mixing method, with Tarvia omitted from No. 1 course.

kettle before heating. From one barrel used on the Narragansett section more than 2½ gallons of water were removed.

The pitch cost, f. o. b. Providence, \$3.00 per barrel of 30 gallons. The freight from Providence to South Ferry cost \$0.27 and the haul, averaging 2,000 ft., cost \$0.10 per barrel, making the total cost \$3.37 per barrel. The pitch used was medium hard, having a melting point at 105 to 110° F., and a specific gravity of 1.25. The volatilization analysis gave the following percentage results:

Volatile at 120° F.....	None
Additional loss at 212°-220°.....	1.73
Additional loss at 240°-260°.....	1.53

Total loss at 260°..... 3.26

A Texas asphalt was used. It was purchased from the Texas Co., and cost, delivered at South Ferry, \$21.50 per ton of 250 gallons. The cost of the haul from the station to the road, an average distance of 2,000 ft., was \$0.10 per barrel of 42 gallons. Therefore, the cost of the asphalt on the road was \$0.09 per gal. This asphaltic product is listed by the Texas Co. as Texaco Asphalt, Grade H. Analysis yields practically no volatile matter to 260° F., a melting point of 140° F.,

an average distance of 1,000 ft., was \$0.11 per barrel. The total cost was \$5.02 per barrel.

The results of the analysis of Tarvia A were as follows:

Specific gravity	1.182
Volatile at 120° F.....	2.4
Additional loss at 212°-220°.....	8.9
Additional loss at 240°-260°.....	6.5

Total loss at 260°.....17.8

The tar-macadam constructed by the mixing method required the services of two tar men at \$1.75 per day of 10 hours, and three common laborers at \$1.50 per day, in addition to the force usually employed on the No. 2 course. The cost of the labor, based on an average rate of progress of 233 sq. yd. per day, was \$0.035 per square yard. The cost of accessories, which would include rent, or interest and depreciation, on tar kettles, dippers, and cost of fuel, was \$0.005 per square yard. The saving by not using a watering cart, \$4.00 per day, was \$0.013 per square yard. The cost of the tar, at 1.25 gal. per square yard, was \$0.093. The total cost of the tar-macadam, in excess of the ordinary macadam, was \$0.12 per square yard.

The difference in cost of the tar-macadam without the tar on the No. 1 course and with that tar (about 1½ gal. per square yard) spread on the No. 1 course, was not appreciable. It is believed that the painting of the No. 1 course is not necessary. In common with all methods of construction, with the single exception of the Gladwell system, it is necessary, in order to secure a maximum penetration of the broken stone by the tar, and adequate incorporation of the tar in the macadam, to allow the No. 2 course to remain without rolling and sanding for from 1 to 3 days, depending on the climatic conditions. It was found to be inadvisable to roll the tarred surface during the warm part of the day, as there was a tendency

and only 8.8 gr. per gallon in a water solution.

The Tarvia was purchased from the Barrett Manufacturing Co., and cost, f. o. b. Boston, Mass., \$3.25 per barrel. The freight to South Ferry, a distance of 70

for the No. 2 course to shift if the tar were soft.

In the construction of the tar-macadam by the penetration method, the tar was spread over the surface by dippers. This method was very unsatisfactory, an unequal application being the result. In order to procure an efficient road, more tar was applied in patching, the original application of 1.25 gallons being thus increased to 1.87 gallons. The penetration secured varied from 1 in. to 2½ in. If this method is to be used, pouring pots with fan-shaped spouts, or a fan-nozzle connected with a hose from a tank-wagon, should be used, or preferably a spreading machine similar to the Laissailly or Aiken. Even with a machine of the most approved type, and with the stone heated either before or after deposition, it is doubtful if the tar-macadam surface thus constructed would be as uniformly bound together as when laid by the mixing method. The average rate of progress on this section was 389 sq. yd. per day. The cost of the labor (which consisted of two tar men and one common laborer) was \$0.013 per square yard. The tar cost \$0.138 per square yard. Adding the cost of accessories and deducting the rebate due to not watering, the total cost was \$0.143 per square yard.

In the construction of tar-macadam by the Gladwell system, the bituminous mastic, consisting of tar and stone chips varying in size from ⅛ to ½ in. in their longest dimensions, was mixed in a regular mortar box. This mixture was spread to a depth of ¾ in., and the No. 2 course was then laid upon it. A coating of tar was spread on the surface, and, after screenings had been applied, the section was thoroughly rolled. The upward penetration of the tar was not measurable, and the surface coat did not penetrate more than 1½ in. In order to procure satisfactory results, it will be necessary to have the No. 1 course so thoroughly compacted as to hold a semi-fluid mixture; the stone composing the No. 2 course should be larger than that generally used, and should be well heated, and, finally, it will be necessary to use a light asphalt roller in order to draw the fluid mixture gradually to the surface, and not attempt to crush the No. 2 course into the binder. Under no circumstances is it believed that the method will prove as efficacious or economical as either the mixing or penetration methods of construction. The rate of progress of this class of work was slow, and would average 156 sq. yd. per day. The labor item was high, two tar men and four common laborers being required, making the labor cost \$0.06 per square yard. The tar, 1 gallon per square yard in the mastic and 1.25 gallons on the surface, cost \$0.167 per square yard. Adding the cost of the accessories and deducting the cost of watering gives a total cost of \$0.22 per square yard.

Tar-pitch-macadam was constructed with and without using chips mixed with the No. 2 course. With hand-mixing, the omission of the chips is preferred, as the tarred chips have a tendency to coagulate, hence preventing a uniform mixture. The pitch and tar were used in the proportion of 1 to 3. The resulting surface was excellent, and could naturally be rolled and finished more expeditiously than tar-macadam. Under certain circumstances, as for instance, on a road subjected to more or less traffic during construction, this desideratum would be a great advantage. On the other hand, the proportion of heavy oils is less than when only tar is used, thus reducing the elasticity of the surface and increasing the danger of cracking in cold weather. The rate of progress and the cost of labor were the same as for tar-macadam constructed by the mixing method. The total cost was \$0.142 per square yard, including \$0.035 for labor, \$0.079 for 1.07 gallons of tar, \$0.036 for 0.32 gallon of pitch, and the usual accessories charge and watering rebate.

In the construction of the tar-asphalt-macadam, 50 per cent tar and 50 per cent asphalt were used, or 0.625 gallon of each per square yard. The resulting road was ideal, from the standpoint of construction and as a finished product. A daily average of 233 sq. yd. was built, making the labor item \$0.035 per square yard. The tar cost \$0.047 per square yard, and the asphalt \$0.056 per square yard. The total cost, including the accessories charge of \$0.008 per square yard, and deducting the cost of watering, was \$0.133 per square yard.

The asphalt-macadam, considered from an economical standpoint, was not successful. The primary difficulty was that it was impossible to obtain a thorough mixture of the asphalt and the stone, coagulation taking place at once. The resulting surface was entirely satisfactory, and could probably be built economically by using a suitable mixing machine and heating the stone. The labor and material items on this work were excessive, the cost of labor being \$0.083 per square yard, while the cost of the 3.59 gallons of asphalt used per square yard was \$0.323. The average rate of progress per day was only 117 sq. yd. The accessories charge was \$0.008, and the watering rebate \$0.013, making a total cost of \$0.401 per square yard.

The Tarvia-macadam constructed by the mixing method appeared to be a *fac-simile* of the tar-macadam made with tar distilled for 3 hours on the road. It is believed that it is primarily a question of economics whether it is preferable to take gas-house coal-tar direct from the works and distill it on the road, or purchase distilled coal-tar, in the form of Tarvia, for example. It should be borne in mind, also, that tar distilled at permanent works

will give a more uniform product. The rate of progress was the same as with tar-macadam, hence all cost items were identical, with the exception of the cost of 1.25 gallons of Tarvia used per square yard which was \$0.124. The total cost of the Tarvia macadam, therefore, was \$0.151 per square yard.

Although the method has not yet been used in Rhode Island, Mr. Blanchard believes that the most satisfactory and economical treatment of existing macadam roads is to tear up the surface to a depth of from 3 to 4 in. with a scarifier, reshape the surface, and then rebuild as a tar-macadam road, using the penetration method of construction. On 1908 work in Rhode Island the cost of scarifying was \$0.007 per square yard. The cost of reshaping, without the addition of new road metal, would be about \$0.005 per square yard; hence the total cost, based on the cost of the penetration method used on the Narragansett Road, would be \$0.105 per square yard. If a tar-spreading machine were used, the cost, without doubt, would be reduced from 15 to 25 per cent.

The oil products used on the highways of Rhode Island include Dustoline, petroleum residuum, Ragland crude oil, petroleum fuel oil, and Texas asphaltic road oil. The average cost of oiling roads in Rhode Island, using about 1/5 gal. per square yard, has been approximately \$0.01 per square yard. Experience would indicate that oiled roads, if efficient, should be treated at least three times during a season of eight months.

Mr. Blanchard's conclusions, based on the maintenance work he has outlined, and the experience of French, English and American engineers, are: First, that highways subjected to heavy high-speed motor-car traffic should be built with a bituminous macadam surface constructed by the mixing method; second, that existing macadam roads subjected to a similar traffic should be reconstructed as bituminous macadam roads using the penetration method, or, if re-surfacing with new road metal is required, by using the mixing method; and third, that the economical and efficient treatment of macadam roads subjected to a moderate amount of motor-car traffic is at present a matter of conjecture, requiring for elucidation the acquisition of reliable detailed information with reference to the use of the various palliatives now on the market.

The present car equipment of the Isthmian Canal Commission, which does not include the Panama Railroad Co., is as follows:

40-ton flats	1,778
50-ton steel flats.....	509
Western dumps	599
Oliver dumps	500
Ingoldsby dumps	12
Goodwin dumps	12
Total	3,411

Cost of Constructing Two Concrete Side Walks.*

The work comprised 625 lin. ft. of walk 5 ft. wide and 155 lin. ft. of walk 1 ft. wide. The construction of both walks is shown by the accompanying sketch; it included, as will be seen, the curb.

The cost of the 5-ft. walk was as follows:

Materials:	
60 cu. yds. cinders at 85 cts. per cu. yd.	\$ 51.00
79 cu. yds. screened gravel at \$1.50 per cu. yd.	118.50
24 cu. yds. sand at \$1 per cu. yd.	24.00
9 cu. yds. pea gravel at \$1 per cu. yd.	9.00
3 tons crushed granite at \$3.50 per ton	10.50
87 barrels cement at \$1.75 per barrel	152.25
Water	2.61
Tile, 625 at 2 cts. each.	12.50

Total\$380.36

Labor:

1 foreman, 6 days at \$3.50.....	\$ 21.00
1 head layer, 4 days at \$2.75.....	11.00
1 assistant layer, 4 days at \$2.50....	10.00
7 laborers, 6 days at \$1.80.....	75.60
3 teams, hauling away excavated material, 2 days at \$1.50.....	27.00

Total\$144.60

Grand total\$524.96

This gives a cost of 82.99 cts. per lin. ft. of walk or 19.9 cts. per sq. ft., including curb.

The cost of the 4-ft. walk was as follows:

Materials:	
30 cu. yds. screened gravel at \$1.50. .	\$ 45.00
18 cu. yds. sand at 85 cts.	15.30
24 cu. yds. cinders at 75 cts.	18.00
8 cu. yds. pit gravel for filling at \$1 ..	8.00
6 cu. yds. pea gravel at \$1.50.	9.00
52 barrels cement at \$1.70.....	88.40
Tile, 455 at 2 cts. each.....	9.10
Water	2.08

Total\$191.88

Labor:

1 foreman, 5 days at \$3.50 per day. .	\$ 17.50
1 head layer, 3 days at \$3.....	9.00
1 assistant layer, 3 days at \$2.50....	7.50
8 laborers, 5 days at \$2.....	80.00

Total\$111.00

Grand total\$308.88

This gives a cost of 70 cts. per lin. ft., or 17.5 cts. per sq. ft., including curb.

Delegates from six cities met recently at Grand Rapids, Mich., and organized the Saginaw Valley Deep Waterway Association with the object of securing the construction of a canal to connect Lakes Michigan and Huron at Grand Haven and Saginaw, Mich.

*Rearranged from the "Canadian Engineer" for Sept. 11, 1908.

The Cost of an Oiled Sand Road in Massachusetts.

The use of oil on earth roads was first tried in this country in California. Several other states have since experimented with oiled roads, among these being Massachusetts. In 1905 this state treated a common sand road in the town of Eastham with a heavy Texas oil, containing about 65 per cent of asphalt. Two applications of this oil were made in 1905 and one application in 1906. The results have been generally satisfactory and the road was in good condition after two years' use, although the Massachusetts Highway Commission, which conducted the experiment, believes that better results can be obtained

two applications 13,118 gallons of oil were used. The area covered was 9,355 sq. yds., and the average was 1.137 gallons per square yard. In the latter half of 1906, 7,980 gallons of oil were spread on top of the road, and after the oil had been given a chance to soak in, the road was covered with stone screenings and sand, 22.15 tons of stone being used. The stone was placed on the oiled surface, and the sand was spread on from time to time, to mix with the free oil.

The third application amounted to .758 of a gallon of oil per square yard of road.

The total amount of oil used was 20,198 gallons, or 2.195 gallons per square yard.

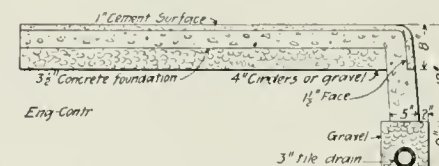
A table is submitted herewith, analyzing the cost of this work.

TABLE SHOWING COST PER GALLON OF OIL IN PLACE AND PER SQUARE YARD OF OILED ROAD IN THE TOWN OF EASTHAM.

	1905—Two coats.		1906—One coat.		Total.
	Per gallon. Cts.	Per sq. yd. Cts.	Per gallon. Cts.	Per sq. yd. Cts.	
Oil	3.500	5.030	4.118	2.920	7.950
Freight on oil	1.547	2.223	1.935	1.370	3.593
Heating, hauling, spreading.....	2.446	3.515	3.967	2.810	6.325
Inspection and foreman	1.737	2.496	2.664	1.880	4.376
Shaping, grading, drainage, sanding and stone	2.544	3.656	2.654	1.860	5.516
Total	11.774	16.920	15.338	10.840	27.760

by a change of method. The grades were easy and no large amount of earth had to be moved. In the last annual report of the Massachusetts Highway Commission the construction of this road is described as follows:

The surface was first shaped, by the use of a road machine, to a crown of about $\frac{3}{4}$



Section of Concrete Sidewalk.

in. to the foot. Over this were spread three coatings of oil, two coats in 1905 and one coat in 1906. The oil was shipped in a tank car equipped with steam pipes for heating it. A small portable steam boiler furnished the heat for the oil in the tank car and the power for pumping it into the cart. The oil was heated to a temperature of about 180° F., and spread onto the road from a watering cart, with a special sprinkler made for the purpose.

Each of the first two coats consisted of about three-quarters of a gallon per square yard of road. After the first coat was applied it was allowed to stand two weeks, when the second coat was put on. After the second coat was applied the whole surface of the roadway was thoroughly chopped up by a disk harrow, rolled with a light horse roller and covered with sand to mix with the free oil. A thin sprinkling of sand was spread over the surface from time to time, to mix with the oil that had worked to the surface. In these

A study of the foregoing table shows that the cost of 1 mile of road, 15 ft. wide, was \$2,442.88.

There is practically no stone in Eastham, or within reach by highway haul. Stone if used would have to be shipped in by rail, and the freight rate is 92 cts. per ton. The road leading from the railroad station is sandy, and only small loads can be teamed over it. As a result of these conditions, the cost of a standard macadam road is high. The traffic is light, and the cost of repairs on an oiled road will be small. The commission believes that on a road of this kind, when the roadbed is of loose sand, the drainage good, the traffic light, and where the cost of more permanent road materials is high, oil can be used to advantage.

Corporations and private citizens throughout New England are beginning to realize the opportunities which this region offers for profitable forest planting. This year about 2,500 acres have been planted in the six New England States by private citizens. In addition, a number of water companies have adopted a forest policy. The largest plantation of this character, which comprises over 1,000 acres, belongs to the Metropolitan Water and Sewerage Board of Clinton, Massachusetts.

A new record for aeroplane flight was established on Oct. 3 at Le Mans, France, by Wilbur Wright. With one passenger he remained in the air for 55 minutes and 37 seconds, circling the field 24 times and covering a distance of about 36 miles. His best previous flight with a passenger was 11 minutes 35 $\frac{1}{2}$ seconds.

Water-works and Sewer Section

Note: This section is devoted to methods and costs of constructing sewers and water-works. It will cover the construction work for all details of water supply and sewerage, including sewage purification and water filtration.

The Cost of Constructing a Brick Sewer in Water-Soaked Sand at Gary, Ind.

In our issue of Aug. 5, 1908, we described in some detail the construction of a sewer in water soaked sand at Gary, Ind. The method adopted was to unwater the sand by bleeding—by sinking well points in the sand along the line of the sewer and drawing out the water with pumps. At the time this description was published the construction had not been completed nor the costs fully analyzed, so that the costs then published were only approximate. Since then the cost of the work has been worked out in considerable detail by City Engineer A. P. Melton and his assistant, Mr. E. M. Scheffow, and have been placed at our disposal by Mr. Melton.

The costs were compiled by keeping a force and time account of the work. The inspector kept the records on blanks prepared for the purpose and checked them with the books of the contractor's time keeper. While some items of cost familiar to the contractor were not thus included, yet the figures given may be considered very close approximations.

The work comprised 4,258 ft. of brick sewer ranging from 7 ft. circular section to 6 ft. 4 in. by 8 ft. 11 in. oval section, all with shells consisting of 2½ rings of brick. The soil was fine sand water soaked below a level about 22 ft. above subgrade; the water soaked sand ran on a slope of about 1 on 15. The trench ranged from 18 to 36 ft. in depth. The method of excavation was fully described in our issue of Aug. 5. Briefly a preliminary wide cut was made some 5 to 15 ft. deep with machines, then well points were sunk and the ground drained, after which excavation proceeded by hand between sheeting. The masonry work and backfilling followed. The cost of construction was divided into the following items: Machine excavation, sheeting, pumping, hauling materials, sewer building, backfilling, materials and organization.

Machine Excavation.—The preliminary wide shallow cut only was excavated by machine. A ¾ cu. yd. Hayward orange peel bucket operated by a 25 H. P. engine was used for the first 1,900 ft. and took out 21,250 cu. yds. at the following cost:

Item.	Total.	Cu. Yd.	Per
Engineer 56 days at \$6. . .	\$336.00		\$0.0153
Fireman 56 days at \$3.50. .	196.00		0.0092
Laborers 255 days at \$1.75 .	446.25		0.0210
Coal 56 shifts at \$5.	280.00		0.0131
Total	\$1,258.25		\$0.0586

At this point the orange peel was removed to the rear to work on backfilling and a Page & Schnable drag scraper excavator was substituted. This machine had a 2 cu. yd. bucket and a 40 H. P. engine; this engine was found to be too weak and was used only until a larger one could be secured. Another objection to the first arrangement was that two men were required to operate the bucket, one at the hoist and one at the swing engine. With the machine as first equipped and operated 15,300 cu. yds. of material were excavated at the following cost:

Item.	Total.	Per Cu. Yd.
Engineer 31 days at \$6. . .	\$186.00	\$0.0122
Fireman 31 days at \$3.50. .	108.50	0.0071
Engineer 31 days at \$3. . .	93.00	0.0060
Laborers 118 days at \$1.75 .	206.50	0.0138
Coal 31 shifts at \$5.	155.00	0.0101

Total \$749.00 \$0.0492

The 40-H. P. engine was replaced by one of 60 H. P. so arranged that one man operated both hoist and swinging engine. With the remodeled outfit 11,000 cu. yds. of material were excavated at the following cost:

Item.	Total.	Per Cu. Yd.
Engineer 21 days at \$6. . .	\$126.00	\$0.0114
Fireman 21 days at \$3.50. .	73.50	0.0067
Laborers 84 days at \$1.75 .	147.00	0.0133
Coal 21 shifts at \$5.	105.00	0.0095

Total \$451.50 \$0.0409

It will be seen that the change of the engines reduced the cost per cubic yard by the amount of the wages of one engineer; the saving was 0.83 cts. per cu. yd. Summarizing we have a cost of \$2,488.75 for excavating 47,550 cu. yds., or of \$0.0523 per cu. yd. For the 4,258 ft. of sewer the cost was 57.9 cts. per lin. ft.

Hand Excavation.—The bottom 13 ft. in depth of the trench was excavated by hand between sheeting; the width of the excavation was approximately 10 ft. The cost of the work was as follows:

Item	Total.	Per Cu. Yd.
Laborers 6,441 days at \$2. .	\$12,882.00	\$0.5413
Foreman 84 days at \$3. . .	552.00	0.0232

Total \$13,434.00 \$0.5645

The total amount of hand excavation was 23,800 cu. yds.

Sheeting.—The sheeting consisted of vertical 2x8-in. by 12-ft. planks held by two pairs of 6x8-in. waling pieces and 9-ft. cross braces spaced 8 ft. apart. In cases of very wet trench a third row of waling and braces was put in; occasionally also horizontal sheeting was used in the bottom.

The cost of driving the sheeting and placing the bracing and also of pulling it was as follows:

Placing:	Total.	Per Lin. Ft.
Laborers 882 days at \$2. . .	\$1,764.00	\$0.1112
Foreman 80 days at \$3.50. .	280.00	0.0658
Carpenters 50 days at \$3. . .	150.00	0.0351

Total \$2,194.00 \$0.5151

Pulling:

Laborers 242 days at \$2. . .	\$484.00	\$0.1136
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Grand total \$2,678.00 \$0.6287

Pumping.—The item of pumping comprises all the work of sinking and shifting the well points and pipe line and the removal of the backwater in the finished part of the sewer. Three Emerson pumps took water from the well points, a fourth handled the backwater and a duplex pump furnished water for boilers, mixing mortar, jetting, etc. The cost was as follows:

Item.	Total.	Per Lin. Ft.
Laborers 542 days at \$1.75\$.	\$948.50	\$0.2227
Pipe line men 958 days at \$2.50	2,395.00	0.5625

Total for pipe work . . . \$3,343.50 \$0.7852

Coal 100 days at \$15. \$1,500.00 \$0.3499

Firemen 855 days at \$3.50. 2,992.50 0.7025

Total for pumping . . . \$4,492.50 \$1.0521

Grand total \$7,836.00 \$1.8376

Pumping costs and pipe line costs have been separated, since the first is a continuous expense which does not vary from day to day, and the second cost is operative only when construction is actually going on.

Hauling Materials.—The materials were hauled 1,500 ft. in steel dump cars running on portable track; the cars were pushed by hand. Coal, lumber, supplies, etc., purchased from local dealers were hauled by team. The cost of hauling was as follows:

Item.	Total.	Per Lin. Ft.
Laborers, 1,219 days at \$2. . .	\$2,438.00	\$0.5725
Foreman 80 days at \$3.50. . .	280.00	0.0657
Teams and drivers 180 days at \$5.50.	990.00	0.2322

Total \$3,708.00 \$0.8701

Sewer Construction.—The construction of the 2½-ring brick sewer was as follows:

Item.	Total.	Per Lin. Ft.
Laborers 1,506 days at \$2. .	\$3,012.00	\$0.7073
Carpenters 50 days at \$3. . .	150.00	0.0351
Form setters 225 days at \$3.75	843.75	0.1981

Brick layers 471 days at \$10 . 4,710.00 | 1.1061 |

Scaffold men 236 days at \$2.75 649.00 | 0.1524 |

Tenders 236 days at \$3.75 885.00 | 0.2076 |

Mixers 387 days at \$2.25 860.75 | 0.2021 |

Total \$11,110.50 \$2.6087

As noted further on the cost of brick and cement for the job was \$14,136.50, or \$2.384

per foot of sewer, making the total cost for labor and materials \$4.993 per lin. ft.

Backfilling.—Enough backfilling was done by hand to cover the sewer and to permit the sheeting to be pulled; the remainder was done with the clam-shell excavator first used for preliminary trenching. The cost of backfilling by hand was as follows:

Item.	Total.	Lin. Ft.	Per
Laborers 378 days at \$2.....	\$756		\$0.18

The cost of backfilling by machine was as follows:

Item.	Total.	Lin. Ft.	Per
Laborers 307 days at \$1.75..	\$537.25		\$0.1261
Engineers 93 days at \$6....	558.00		0.1287
Firemen 93 days at \$3.50...	325.50		0.0764
Coal 93 shifts at \$5.....	465.00		0.1092

Total\$1,885.75 \$0.4404

Materials.—The cost of the materials used in the job was as follows:

Item.	Total.	Lin. Ft.	Per
2,221,000 brick at \$5.....	\$11,105.00		\$2.6080
Utica cement, 6,663 sacks, at 20 cts.....	1,332.60		0.3106
Universal cement, 6,663 sacks, at 30 cts.....	1,998.90		0.4694
30 M. ft. B. M. lumber at \$20	600.00		0.1409

Total\$15,036.50 \$3.5289

Superintendence and General Expenses.—The costs of superintendence and general expenses were as follows:

Superintendence.	Total.	Lin. Ft.	Per
Superintendent 4 mos. at \$150	\$ 600		\$0.1409
Gen'l foreman 4 mos. at \$125	500		0.1174
Master mechanic 4 mos. at \$200	800		0.1855
Time keeper 3 mos. at \$60..	180		0.0422
Team 100 days at \$4.....	400		0.0927

Total\$2,480 \$0.5787

General expenses:

Water boys 220 days at \$1.50.	\$330		\$0.0775
Clearing right of way 60 days at \$1.50.....	90		0.0211

Total\$420 \$0.0986

Summarizing we have the cost per lineal foot of sewer as follows:

Item.	Per Lin. Ft.
Excavation by machine.....	\$ 0.58
Excavation by hand.....	3.15
Sheeting	0.63
Hauling materials.....	0.87
Pumping	1.84
Laying sewer.....	2.61
Backfilling by hand.....	0.18
Backfilling by machine.....	0.44
Materials	3.53
Superintendence and general.....	0.68
Depreciation, repairs, setting up machines	1.50
Making 3 railway crossings (\$2,500) ..	0.58
Total	\$16.59

The work was begun on April 2 and was completed on Aug. 5, 1908, during which time only 11 days were lost by the brick layers.

Methods and Results of Cleaning Water Mains in Pittsburg, Pa.*

BY C. O. DAUGHADAY.†

There is not a city in the United States in which a water-works system has been installed for any length of time where the great mains do not become inadequate for supplying the demand. In some cases, of course, it is due to the growth of the city being far more rapid than originally calculated, and then the only solution is the one of replacing the too small mains with those of a larger carrying capacity. However, the more frequent cases are where the mains become clogged with tubercular formation or mud, so that their carrying capacity is so reduced as to be insufficient to meet the demand.

There are two solutions to this latter case, viz., to take up the mains and replace them with new mains, or to clean them. As cleaning is by far the cheaper operation, this seems to be the reasonable course to pursue, provided the mains themselves are in good condition, aside from this stoppage by tubercular formation or mud.

The city of Pittsburg first took up the cleaning of mains about two years ago. The pressure in part of our Hazelwood territory for five or six years back kept gradually decreasing. This territory was supplied by an 8-in. supply main, about 14 years old, passing through Schenley Park. At the end of this main the pressure was 34 lbs. below the theoretical static head. A thorough survey was made of this main by means of pitometers, but no leaks could be discovered. In making these pitometer tests, it was found that a coating of scale on the inside of the pipe greatly reduced the diameter. It was, therefore, decided to clean this main as an experiment, and the contract for cleaning was awarded to the National Water Main Cleaning Co., of New York city. The scale taken from this pipe was carefully measured, and from this it was estimated that a coating of 0.32 in. covered the entire last section of cleaned pipe, varying from $\frac{1}{8}$ to $\frac{3}{4}$ in. at different locations. In the cleaning, two pieces of lead, caused by defective yarning, were removed, one of these weighing 45 lbs. The results of the cleaning operation were as follows:

	Before Cleaning.	After Cleaning.
Diameter, in.	7½	8
Velocity, ft. per sec....	5.3	10.3
Discharge, gals. per min.	730	1620
Increase, per cent.....	...	121

There were 3,264 lin. ft. of this main

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cleaned, the discharge being taken by means of a 6-in. Crest meter.

As the city had trouble in the dropping of the pressure in the Oakland District, where the mains were mostly old, it was decided to clean some of these this year. This work was taken up about a month ago, and is now nearly completed. Following are the results of these operations:

SIX-INCH MAIN ON BOUQUET ST., FIFTH AVE., SOUTH.

	Before Cleaning.	After Cleaning.
Diameter, in.	5¼	6
Coef. of velocity, per cent	71	85
Velocity, ft. per sec....	4.26	11.56
Discharge, gals per min..	370	1019
Increase, per cent.....	...	175

The velocity and discharge in this case, as in all other tests of mains cleaned this year, were determined by means of pitometers. The coefficient of velocity is the ratio between the average velocity and the maximum velocity of the pipe.

SIX-INCH MAIN ON BOUQUET ST., FRAZIER ST., EAST.

	Before Cleaning.	After Cleaning.
Diameter, in.	5¼	6
Coef. of velocity, per ct.	76	90
Velocity, ft. per sec....	3.71	7.6
Discharge, gals. per min.	252	671
Increase, per cent.....	...	166

There were 1,800 lin. ft. of this line cleaned.

SIX-INCH MAIN ON WARD ST., FRAZIER ST., EAST.

	Before Cleaning.	After Cleaning.
Diameter, in.	5¼	6
Coef. of velocity, per ct.	79	88
Velocity, ft. per sec....	6.38	10.47
Discharge, gals. per min.	563	923
Increase, per cent.....	...	64

There were 864 lin. ft. of this line cleaned. This main was comparatively new, and the inside was in fairly good condition, as will be seen by the coefficient of velocity being 79 per cent. before cleaning.

This would account for the smaller percentage of increase as compared to other mains cleaned.

An interesting test was made in connection with the cleaning of a 4-in. main on Meyran Ave., from Fifth Ave., south, to determine the relation of the percentage of increase to the length cleaned. The flow was determined through the full length, 1,834 ft., before cleaning. The pipe was then broken, and at 905½ ft., the flow determined. It was then broken at 477½ ft., and flow determined. After cleaning, the same process was followed out in the reverse order. Following are the results:

	Before Cleaning.	After Cleaning.
At 1834 feet.		
Diameter, in.	2½	4
Coef. of velocity, per ct.	77	85
Velocity, ft. per sec....	2.19	14.58
Discharge, gals. per min.	128	384
Increase, per cent.....	...	200

	Before Cleaning.	After Cleaning.
At 905½ feet.		
Diameter, in.	25½	4
Coef. of velocity, per ct..	73	82
Velocity, ft. per sec.....	4.09	12.41
Discharge, gals. per min.	160	485
Increase, per cent.....	...	203

	Before Cleaning.	After Cleaning.
At 477½ feet.		
Diameter, in.	25½	4
Coef. of velocity, per ct..	72	83
Velocity, ft. per sec.....	5.24	15.67
Discharge, gals. per min.	203	614
Increase, per cent.....	...	199½

Another interesting test was made, on a 4-in. line on Craft Ave., before and after cleaning, this line having been laid about 40 years. At some places in this line, the opening was nearly stopped up by tuberculation.

	Before Cleaning.	After Cleaning.
Diameter, in.	2¼	4
Coef. of velocity, per ct..	47	76
Velocity, ft. per sec....	2.19	14.58
Discharge, gals. per min.	86	571
Increase, per cent.....	...	564

As will be seen from these tests, the percentage of increase varies from 64 to 564. This determination of percentage of increase simply tends to tell us how dirty the pipes were when cleaned. What would be a better result is to obtain the percentage of maximum carrying capacity of the mains after cleaning. At present to obtain the theoretical maximum carrying capacity we have about twelve different formulas which can nearly all be reduced to the well known formula

$$V = C \sqrt{RS}$$

The only trouble we then have, is with C, the coefficient, which varies so that under different conditions that engineers are at somewhat a loss what to use for this variable. For instance, in a 6-in. pipe we can find this coefficient varying from 70 to 107, all taken from results of well-conducted experiments. This coefficient being so variable it is almost impossible to say at present that mains shall be cleaned to 95 per cent. or any other per cent. of their maximum carrying capacity. Why should it not be better then, as experiments tend to show that the cleaning of water pipe is a saving operation, for the water company or municipality to install a hatch-box, for cleaning, when pipes are first laid, so that interior surfaces of pipes can be examined from time to time, and also to put in a pitometer tap and test these lines when first laid, in order to determine the maximum carrying capacity. Then, when pipes are cleaned, bring them back to a reasonable percentage of maximum carrying capacity, as found, in the new pipes say for the first year.

The total mileage of Brazilian railways is 11,204, of which 4,939 miles are government owned.

Bridges, Buildings and Foundations

Note: This section is devoted to methods and costs of constructing steel and masonry bridges and buildings and of foundation work of all kinds. It will give special attention to erection plant and tools, falseworks and centers and cost data of all kinds.

Data on 14 Steel Bridges (Highway and Railway) Including Weights, Costs, Etc.

In our issue of Sept. 2 we gave data on 32 concrete and reinforced concrete bridges, giving the concrete yardage, or cost, or both, of each bridge. In this issue we give corresponding data on steel bridges. Our readers are also referred to our issue of Sept. 23, to an article entitled "The Weights of Steel Bridges for Highway, Railway and Electric Railway Spans of 10 ft. to 300 ft." In subsequent issues we shall give a continuation of the data given in the present issue.

All formulas for estimating weights of bridges are based upon designs of bridges of moderate spans, up to about 300 ft., hence the data given in this article will be found especially valuable in making estimates on long span bridges. No formulas at all have been published on swing bridges nor on lift bridges.

Weight of a 465-ft Span Highway Bridge.—The longest highway truss span in America was built in 1901 across the Miami River at New Baltimore, Ohio. It has a span of 465 ft. c. to c. of end pins, and a depth of 66 ft. at the middle. The pin connected trusses are 25 ft. apart in the clear. The bridge is designed for a live load of 2,600 lbs. per lin. ft., with a live load of 100 lbs. per sq. ft. on the floor system and a 6-ton road roller as a concentrated load. The floor system consists of plate girder floor beams, I-beam stringers, and 2½-in. plank floor. There is no sidewalk and no street railway track. The weight of the bridge is 1,000,000 lbs., or 2,150 lbs. per lin. ft., or 86 lbs. per sq. ft.

Weight of a 406-ft. Span Highway Bridge.—A very long highway truss span was built in 1899 across the Miami River at Hamilton, Ohio. The span is 406 ft. c. to c. of end pins. The trusses are 50 ft. deep at the middle and spaced 26½ ft. c. to c. The roadway is 22 ft. wide, and the two cantilever sidewalks are 6 ft. wide each, making a total floor width of 34 ft. The trusses are calculated for a dead load of 5,000 lbs. per lin. ft. of span and a live load of 2,720 lbs. per lin. ft. of span, or 80 lbs. per sq. ft. of floor. The floor system is calculated for a 20-ton roller on two axles 12 ft. apart, or a 16-ton electric car. The floor of the roadway is asphalt blocks on concrete laid on buckle plates, supported by I-beam stringers. The sidewalks are concrete slabs. The total weight of steel in the bridge is 1,300,000 lbs.

Weight and Cost of a Highway Bridge, 120-ft. Spans.—A steel highway bridge was built in 1905 across the Wabash River at Terre Haute, Ind. It is 812 ft. long between abutments, and consists of 6 spans of 120 ft. each and one 75-ft. span in the center. The roadway is 50 ft. wide, and there is an 8-ft. cantilever sidewalk on each side, making a total floor width of 66 ft. It is a deck bridge, and each span has two riveted trusses 53 ft. c. to c., with three intermediate plate girders. The roadway is paved with brick. The total weight of steel in the bridge is 4,144,000 lbs. including 88,000 lbs. of street car rails. There are 2,330 cu. yds. of concrete in the two abutments and 3,900 cu. yds. in the six piers; there are 718 piles. The piers average 50 ft. high. The substructure cost \$78,700, and the superstructure cost \$192,500, a total of \$271,200, by contract, including the removal of an old bridge and the building of a temporary bridge, which is equivalent to \$334 per lin. ft., or \$5 per sq. ft. of floor area.

Weight of a 450-ft. Span Highway Swing Bridge.—A highway swing span of unusual length was built across the Connecticut River in 1896. The bridge is 450 ft. long. The trusses are 26 ft. c. to c., providing for one line of electric cars and two lines of carriages. The floor is designed to carry 100 lbs. per sq. ft., 14 ton electric cars or a 10 ton wagon. The trusses are designed to carry a live load of 1,500 lbs. per lin. ft. for chords and 2,000 lbs. for web. The floor consists of 4x14-in. yellow pine stringers spaced 2½ ft. apart, supporting two layers of plank, 3 in. and 2 in., respectively. The stringers for the car track are 15-in. steel beams weighing 42 lbs. per ft. There are 22 panels, depth 21 to 55 ft. The turntable is rim bearing. The drum is 4 ft. deep and 31 ft. diameter. Three 25-HP. motors are used, one for turning and two for blocking up the ends. An extra motor is provided. To open takes the motor 30 seconds. Working on 10-ft. levers the bridge is turned by four men in 8 minutes. The total weight of drawbridge superstructure, including drum and flooring, is 1,380,000 lbs.

Weight of a 520-ft. Double Track Swing Bridge.—The longest swing span in the world is the Interstate bridge. It is a double track railway draw bridge, built in 1903, across the Missouri River at East Omaha, Neb. The trusses were designed to carry a live load of 11,180 lbs. per lin. ft. of bridge. This heavy load was allowed in case it should be desired to provide a cantilevered roadway and sidewalk 16 ft.

wide on the outside of each truss. The weight of this 520-ft. draw span is 3,900,000 lbs. There were also 9 plate girder 60-ft. spans in the approach, having a total length of 575 ft., and a total weight of 1,773,000 lbs. The pivot pier was sunk to bed rock, a depth of 120 ft. below low water, by open dredging inside a steel cylinder.

The following are the quantities in the substructure:

	Cu Yds.
Mass in cribs and pneumatic caissons of 2 piers 80 ft. deep.....	4,180
Mass in base of pivot pier.....	5,390
Mass in bases of 8-pile piers and 2 abutments	2,330
Masonry in shafts of 4 large piers...	2,135
Concrete in shafts of 8 shore piers and 2 abutments.....	1,550
	Lin. Ft.
Piling below bases of 8 shore piers and abutments	19,900
	Lbs.
Steel in pivot pier "well" or open caisson	580,000

The "4 large piers" above mentioned are the pivot pier of the draw span and its two rest piers, and a third rest pier for an old existing draw span.

The contract price for this 520-ft. swing bridge and approaches was \$600,000.

Weight of a 450-ft. Double Track Swing Bridge.—A double track draw bridge, with 5 approach (single track) spans, was built in 1905 across the Tennessee River for the Illinois Central Ry., to replace a lighter steel bridge built 17 years previously. The draw bridge is 450 ft. long, and about 25 ft. c. to c. of trusses. Three of the approach spans are 300 ft. each, and two are 150 ft. each, and are all single track, the trusses being 17½ ft. c. to c. The weights of steel in these spans are as follows:

	Lbs.
1 double track draw span (450 ft.) and turntable	2,576,000
3 single track spans, 300 ft. each..	4,074,000
2 single track spans, 150 ft. each..	764,000
Total.....	7,414,000

The price for the draw span was 4.45 cents per lb. ready to assemble; and the price for the pin connected truss spans was 3.64 cents per lb. The cost by contract for erection was \$90,000, which is about 1¼ cents per lb. The pivot pier is 62 ft. high, and 47 ft. diameter. It contains 873 cu. yds. of concrete footing and 1,356 cu. yds. of concrete above the footing, or a total of 2,229 cu. yds., and 16,200 lbs. of reinforcing rods. It rests on 305 piles.

Weight of a 438-ft. Single Track Swing Bridge.—As a part of the single track bridge, built in 1899 over the Mississippi River, for the Davenport, Rock Island and Northwestern Ry., there are one 361-ft., three 296-ft., and three 200-ft. pin-connected truss spans, beside a 438-ft. swing span which is described subsequently. The trusses are designed for Cooper's Class E

35-train load, and the floor system for Class E-40. The trusses are 18½ ft. c. to c. The weights of each span is as follows:

	Lbs.
438-ft. swing span (including ma- chinery)	1,400,600
361-ft. span (c. to c. of end pins) ..	1,039,100
296-ft. span (c. to c. of end pins) ..	712,100
200-ft. span (c. to c. of end pins) ..	410,000

Weight and Cost of a 331-ft. Four Track Swing Bridge.—A four track swing bridge was built in 1900 across the Chicago Drainage canal at West 46th street, Chicago, for the Chicago & Western Indiana R. R. It is unique among four track swing bridges in that it has two trusses instead of three. By this arrangement the center pier is only 43 ft. diameter, thus saving about 20 ft. of length over a three-truss bridge that gives the same clear waterway. The bridge is 334 ft. long c. to c. of end bearings. It is 29½ ft. c. to c. of trusses, two of the tracks being supported on cantilever floor beams outside the trusses. The total width is 57 ft. The live load, continuous girder of four supports, is 1,980 lbs. per lin. ft. on the adjacent inside track, 4,200 lbs. per lin. ft. on the adjacent outside track, with no load on the distant outside track.

The weight of steel and iron is 2,692,000 lbs., exclusive of the operating machinery.

The pier is octagonal, 44 ft. diameter, over coping, masonry shell 7 ft. thick, filled with earth inside, is 30 ft. high and rests on clay. The substructure cost \$51,353, the contract prices being: Excavation, 51 cts.; concrete, \$7.30; stone masonry, \$13.35 per cu. yd. The superstructure cost \$131,393, or nearly 4.9 cts. per lb. including the floor. The total cost was \$182,746, or \$547 per lin. ft. of bridge, or \$137 per lin. ft. of track.

Weight of a 231-ft. Single Track Swing Bridge.—A single track swing bridge was built in 1904 across the St. Joseph River, for the Pere Marquette Ry., to replace an older span having become too light for modern locomotives. The bridge is 231 ft. c. to c. of end floor beams, and 17 ft. 8 ins. c. to c. of trusses. It was designed for Cooper's Class E loading, and its weight is 600,000 lbs. It is operated by a 30-HP. gasoline engine which opens or closes it in one minute.

Weight of a 216-ft. Double Track Swing Bridge.—A double track swing bridge was built in 1899 across Kinnickinnic River, near Milwaukee, for the Chicago & Northwestern Ry., to replace a single track pin-connected bridge built 19 years previously. It is a riveted lattice truss draw bridge, 216 ft. long, trusses 27 ft. apart in the clear, and designed for a load of two 131½-ton engines followed by a train weighing 4,000 lbs. per lin. ft. on each track. Its weight is 1,200,000 lbs. including track, machinery, etc.

Weight and Cost of a 1,504-ft. (3 spans) Cantilever Double Track Bridge.—The

longest cantilever railway bridge in America is a bridge finished in 1903 across the Monongahela River at Pittsburg, for the Wabash R. R. It is 1,504 ft. long exclusive of approaches. The channel span is 812 ft. c. to c. of piers, and each of the shore spans is 346 ft. c. to c. of piers. The steel towers are 126 ft. high, and the depth of the suspended span is 60 ft. The live load consists of two consolidation engines (on each track) followed by a train load of 4,500 lbs. per lin. ft. The weight of the superstructure is 14,000,000 lbs., or 9,300 lbs. per lin. ft. The cost of substructure and superstructure was \$800,000, or \$533 per lin. ft.

The four piers were sunk to rock by the pneumatic caisson process. The height of the four piers averaged 110 ft., of which 35 ft. is below low water.

Weight and Cost of a 1,296-ft. (3 spans) Cantilever Double Track Bridge.—A double track cantilever bridge was finished in 1903 across the Ohio River, at Mingo Junction, Ohio, for the Wabash R. R. It is 1,296 ft. long exclusive of approaches. The channel span is 700 ft. and each of the two shore spans is 298 ft. c. to c. of piers. The steel towers are 109 ft. high, and the depth of the suspended span is 51¾ ft. Two of the piers have caisson foundations and are 115 ft. high, 25 ft. of which is below low water level. One pier is 100 ft. high, of which only 10 ft. is below low water. There is an abutment (instead of a fourth pier) 40 ft. high. The weight of the superstructure is 12,000,000 lbs. exclusive of approaches. The cost of the substructure and superstructure was \$750,000, or \$577 per lin. ft.

Weight and Cost of a 2,750-ft. (5 spans) Cantilever Double Track Bridge.—A double track cantilever bridge was finished in 1905 across the Mississippi River at Thebes, Ill., for the Illinois Central and other railways. It has a length of 2,750 ft. (exclusive of concrete approaches) and consists of 5 spans: one 671 ft., two 521 ft., and two 518 ft., measured center to center of piers. The steel superstructure weighs 24,000,000 lbs., and cost \$1,400,000, and the substructure cost \$600,000, a total of \$2,000,000, which is \$800 per lin. ft. The piers have an average height of about 115 ft. from the cutting edge of the caisson to the top of the pier, and the water averages 20 ft. deep when low. One pier was sunk to a depth of 40 ft. below low water. There is a double track concrete viaduct approach on each side, having a total length of about 1,200 ft., consisting of 65-ft. arches. The height of this viaduct is about 100 ft., and its cost was \$300,000, or about \$250 per lin. ft.

Weight of a 1,380-ft. (3 spans) Cantilever Highway Bridge.—A cantilever highway bridge was finished in 1903 across the Ohio River at Marietta, Ohio, for the Ohio River Bridge and Ferry Co. Its length is 1,380 ft. exclusive of two approach spans of 220 ft. each and a plate girder viaduct

640 ft. long, but with these the total length is 2,460 ft. The width is 28 ft. c. to c. of trusses, or 25 ft. clear width of roadway including a $4\frac{1}{2}$ -ft. sidewalk. The live load for the trusses was assumed at 60 lbs. per sq. ft.; and for the floor system it was assumed at 80 lbs. per sq. ft. or a steam roller of 15 tons. The cantilever is of peculiar design, due to necessity of providing two channels and of placing one of the piers in a shallow part of the river. The length of the main channel span is 650 ft.; the south anchorage span is 600 ft.; the north anchorage span is 130 ft.; all c. to c. of piers. The trusses are pin connected. The floor system consists of plate girder floor beams, timber stringers, and plank floor. The weight is 4,800,000 lbs., including the approach spans and the viaduct.

Weights and Costs of Suspension, Arch and Bascule Bridges.—In a subsequent issue, data will be given as to these types of bridges, also as to steel viaducts.

Statistics as to the Life of Steel Railway Bridges.

Considering the economic importance of the subject, it is astonishing that no tabulated statistics as to the life of American steel railway bridges can be found in print.

Bridge engineers are accustomed to denominate wooden bridges as "temporary," while they call steel bridges "permanent." The annual reports of railway managers to stockholders contain these expressions, and there is a general acquiescence in the propriety of their application. But the facts are that steel railway bridges are so far from being permanent that they, too, should be classed as temporary.

We must not be misunderstood as decrying the lasting qualities of steel itself, for there is abundant evidence that iron and steel are exceedingly lasting under certain conditions. Let us illustrate.

The "first iron railway bridge" was built in 1823, for the Stockton & Darlington Ry., at West Auckland, England, and was not removed until 1903, after 80 years of service. This bridge is illustrated and described in the "Railroad Gazette," July 8, 1904, p. 125. The bridge was, in fact, an iron trestle with cast iron posts and four iron spans of 12 ft. 8 ins. each. The spans consisted of double arch members of wrought iron united by cast iron struts.

As is well known, the life of an iron or steel railway bridge is not limited by the durability of the iron or steel itself, but by the ability of the bridge to withstand the steadily increasing loads imposed upon it.

The average age of the 1,000 locomotives in use on the Northern Pacific Railway is 10.4 years. There are in service (or, at least, there were two years ago) several locomotives 34 years old. This road has been in existence so long that its rolling stock may be said to have reached a con-

dition of normal renewals. When a condition of normal renewals is reached as to cross ties, the life of the average tie is just twice the age of the existing average tie. If the age of the average tie is found to be 5 years, then the life of the average tie is 10 years, and a condition of normal renewals of 10 per cent per annum exists. In like manner, rolling stock ultimately approximates a condition of normal renewals. It does not reach exactly that condition, due to the steady growth of traffic on the railway. But, if we multiply the 10.4 years by 2, we have 20.8 years, which is the approximate average life of locomotives on the Northern Pacific Ry. Due to the increase in the number of locomotives each year, the true average life is slightly greater than the 20.8 years thus ascertained.

Since there has been a complete renewal of locomotives in about 20 years, and since the locomotives have grown progressively heavier, it is logical to look for a renewal of steel bridges in about the same length of time, and in fact that is what has occurred. We shall publish a large number of actual cases to prove this fact, beginning with the accompanying table of 10 bridges.

TABLE SHOWING LIFE OF TEN RAILWAY BRIDGES.

Item No.	Name of R. R.	Location of Bridge.	When Built.	Life, Years.
1.	C. M. & St. P.	Rock River	1884	19
2.	Wabash	Sangamon River	1885	21
3.	C. & E. & Q.	Big Rock Creek	1884	22
4.	Ill. Cent.	Big Muddy River	1889	13
5.	Ill. Cent.	Tennessee River	1888	17
6.	C. & N. W.	Kinnikinnie River	1880	19
7.	P. M.	St. Joseph River	1887	17
8.	Grand Trunk	Niagara	1877	19
9.	C. M. & St. P.	Menominee River	1886	17
10.	C. R. R. of N. J.	Newark Bay	1887	17
Average of the above				18.1

It will be noted that the average life of these 10 steel railway bridges has been 18.1 years. When it is remembered that the life of an uncovered Howe truss wooden bridge is rarely less than 10 years and is frequently 20 years (see committee report of the Association of Railway Superintendents of Bridges and Buildings, Oct. 1899), what becomes of the designation "permanent" as applied to steel in contrast with wooden railway bridges? The consensus of opinion given in the report above cited was to the effect that a Howe truss, properly housed in, would last more than 40 years. A housed in wooden highway bridge, of the Howe truss type, was taken down at Zanesville, Ohio, after 65 years of service.

With such statistics before us, we are forced to conclude that most railway bridge engineers have fallen into serious error in not giving proper consideration to the temporary character of steel railway bridges as heretofore designed.

While we cannot predict with accuracy what the increase in railway bridge loading will be in the future, there is nothing more certain than that an increase will occur. Since the first railway was built, there has been a steady growth in the size of locomotives and cars. When will it cease? No

man can tell. Therefore, if we plan for the future upon the teachings of the past 80 years, we must either make due allowance for increased weight of rolling stock when designing steel railway bridges, or we must cease calling them "permanent" and apply to them, as to timber bridges, their proper designation, "temporary."

In addition to the important bearing that such statistics as are here given have upon bridge design, there is the further importance of such data in solving problems of railway appraisal. In making his appraisal of railways of Washington for the State Railroad Commission, the managing editor of *ENGINEERING-CONTRACTING* had to make an estimate of the "present value" of all structures. Nearly all the steel railway bridges in Washington are comparatively new, and, as the appraisal of the railways was made primarily for rate making purposes, Mr. Gillette assigned no depreciation to the steel bridges. This gave the railways more than "the benefit of the doubt," for there can be no doubt that there is no real permanency in steel railway bridges as at present designed. For taxation purposes, it is clear that a depreciation of about 5 per cent per annum should be made from

the first cost of all steel railway bridges.

Even a casual study of bridge books and bridge literature must impress an engineer with the lack of attention that engineers have given to this all important subject of the life of bridges. The text books treat the problems of bridge design largely as problems in pure mathematics and mechanics, and ignore many equally important principles of bridge economics. Most of the designers of reinforced concrete railway bridges are making the same blunders that have characterized the designers of steel railway bridges, namely, designing for present loadings without provision for the future.

We trust that the statistics here given and that are to follow, will direct the attention of bridge designers to the importance of giving proper consideration to the life of bridges.

Data on Riveting.

In the construction of the Chubbuck Valley Viaduct, there were 18,869 seven-eighths inch rivets driven in the field. The average day's work for a gang of 4 men was 192 rivets. The best day's work was 315, all hand driven. The defective rivets amounted to less than 2 per cent.

Railway Section

Note: This section is devoted to methods and costs of constructing railways. It will cover road-bed and track construction, contractor's plant and organization, surveying methods and permanent way structures.

The Cost of Track Laying.

Contracts for track laying on new railway construction are not at all uniform as to specified methods of payment, largely because of varying practice as to the time and method of ballasting. If the ballast is not placed at the time of track laying, it is customary to divide the payment for track work into two parts—(1) track laying and (2) surfacing track.

Track laying involves the unloading of the ties and rails from the cars, trimming the earth to true grade to receive the ties, delivering and placing the ties and rails thereon, curving the rails and joining them.

The railway company stands the cost of loading the ties, rails, etc., at the material yard and the transportation to the site of track laying work. This expense is charged upon the railway company's books as "train service."

Surfacing track consists in shoveling earth in between the ties, aligning the track and tamping. Where suitable material for filling between the ties is not at hand, it is hauled in on cars at the expense of the railway company, and the contractor loads and unloads these cars at a separate unit price agreed upon. Such material if hauled in is usually gravel, and is called ballast.

On the Northern Pacific Railway the contract prices for track laying and surfacing have been quite constant for the last 30 years, being about \$250 per mile for track laying and \$200 per mile for surfacing. The engineer's preliminary estimates of the cost of train service have usually been about \$100 a mile, but the actual cost has ranged from \$75 to \$150 a mile. Summarizing we have:

	Per Mile.
Track laying (contract price).....	\$250
Surfacing (contract price).....	200
Train service (including loading)....	125
Total	\$575

Of course the length of all permanent sidings is included in arriving at the mileage.

In addition to this item of train service there is the cost of transporting workmen to the site of the work, for, under most contracts, the railway company agrees to carry the contractor's workmen free over its own lines. The railway also frequently agrees to carry the contractor's plant, including animals, free for some prescribed distance. This cost of transporting men and plant has seldom exceeded \$25 per mile of track. This brings the total cost up to about \$600 a mile. An allowance

greater than this is usually an error on the side of liberality.

The item that we have called "train service" is commonly underestimated by engineers who have not had access to the books of railway companies, so that an analysis of the items that go to make up this cost of train service will prove of decided value to the majority of railway engineers. Such an analysis follows:

	Per Day.
1 engineman.....	\$ 3.60
1 fireman.....	2.00
1 conductor.....	3.00
2 brakemen at \$2.....	4.00
1 engine.....	7.50
14 flat cars at 35 cts.....	4.90
4 tons coal at \$3.....	12.00
Oil and waste.....	.75
Total	\$37.75

In round numbers we may call it \$40 a day for a train and train crew.

It must be remembered that the train crew is paid by the month and not by the day. Hence the average number of miles of track laid per month should be divided by the total number of working days in the month and not by the number of days actually worked in arriving at an average daily mileage for track laying to be divided into the cost of train service.

It must also be remembered that the number of trains required can not be determined by the *average* haul of materials, but by the *longest* haul from the material yards to the front.

Usually three trains are needed in building a long line, where the track laying gang is large enough to lay 2 miles of track a day when working. Due to spells of bad weather, delays occasioned by non-completion of bridges, etc., the monthly average will not be more than 40 miles, or 1.5 miles per working day. Hence 3 trains at \$40 equals \$120, which divided by 1.5 miles gives \$80 per mile for train service.

To this must be added the cost of unloading rails and ties in the material yard. The rails and fastenings weigh about 120 tons per mile, and the ties weigh about 200 tons per mile of track. Practically all the steel has to be unloaded and loaded again, but usually the ties are delivered with such regularity that only a small portion of them needs to be stored. Contract prices for loading rails at 10 cts. a ton are not uncommon, although the price frequently runs as high as 25 cts. By company forces, materials should be unloaded and reloaded for 25 cts. a ton. Hence if all the track materials were thus handled, the yard expense would not exceed \$80 per mile of

track. Under ordinary conditions not more than half the materials are thus handled in the yard, so that the yard cost averages about \$45 per mile of track. Adding this to the item of train service we have the total of \$125 per mile of track, as above stated.

Where all the track is to be ballasted at once, the present practice is to include the cost of "surfacing track" as a part of the cost of ballasting.

To indicate how the contract prices run under such conditions, we may cite the bids on the Portland & Seattle Ry., in 1906, which were as follows:

Track laying, including loading of track materials but not including unloading in the yard, \$300 per mile.

Tie plating (fully tie plated), \$75 per mile.

Labor on single tie plates, 1½ cts. each.

Labor on switches, \$25 each.

Ballast, 27 cts. per cu. yd.

This price is for gravel ballast and includes all the cost of loading and unloading the same and tamping it under the ties, and lining up the track, but does not include the train service nor the wear and tear on the steam shovel which is furnished by the railway company. The train service rarely exceeds 8 cts. per cu. yd. and another 1 ct. will usually cover steam shovel repairs and depreciation. This 9 cts. added to the contract price of 27 cts. gives a total of 36 cts. per cu. yd. of gravel ballast in place. This is a liberal estimate under ordinary conditions. As to the cost of ballasting, however, we intend discussing the subject in great detail in a subsequent issue, giving many records of actual cost.

We give the following as confirming the above given estimate of \$150 per mile for train service, yard work and transportation of men:

On the Seattle and Montana Ry., built in 1891, the train service, etc., cost \$67 per mile of track for 79 miles.

On the Idaho division of the Great Northern Ry. (110 miles long), built in 1892, the train service, etc., cost \$125 per mile of track.

On the Cascade division of the Northern Pacific Ry., built in 1884, the cost of train service, etc., was \$170 per mile of track. This was a difficult section over the Cascade Mountains. On an easier section the corresponding cost was \$150 per mile.

On the Snake River branch of the O. R. & N., built in 1899, the cost of train service, etc., was \$154 per mile, to which must be added \$18 per mile for the cost of transporting men, etc.

It will be seen from these figures that engineers quite commonly underestimate the total cost of track laying and surfacing. Frequently estimates may be seen that contain no allowance whatever for train service and material yard work.

For details as to the organization of gangs, wages and actual costs of track laying and surfacing, the reader is referred to

Gillette's "Handbook of Cost Data," pages 537 to 546.

The Weight and Cost of Steel in Brooklyn Elevated Railways.

In 1896 there were about 20 miles of double track elevated railways in Brooklyn, and the average weight of steel was 6,780,000 lbs. per mile, or nearly 1,300 lbs. per lin. ft. This weight was about 20 per cent in excess of what would have been necessary if the columns could have been placed in the roadway; but, due to the narrow streets, fully 4 per cent of the columns were placed at the edge of the sidewalks, necessitating transverse girders 35 to 45 ft. long. The average length of the longitudinal girders was 50 ft. The following is typical of the distribution of the steel in more modern sections (built in 1893), which averaged 7,840,000 lbs. per mile, or nearly 1,500 lbs. per lin. ft., the transverse girders being 45 ft. long:

	Per Cent.
Columns	11.5
Transverse girders.....	20.5
Longitudinal girders (two tracks)...	57.0
Station platforms.....	5.0
Bracing	6.0
Total	100.0

This work cost nearly 3 cts. per lb. erected, at which rate the steel work cost nearly \$45 per lin. ft., or less than \$240,000 per mile. Ties 7x8 ins., spaced 15 ins. c. to c., were used; guard rails 6x8 ins. The earlier lines were built with 60 lb. rails, but in 1893 rails weighing 85 lbs. were adopted. Stations average 1,800 ft. apart. The locomotives weighed 45,000 to 56,000 lbs., the wheel base being 16 ft.

The Cost of the Early Elevated Railways in New York City.

The cost of a mile of double track elevated railway on Manhattan Island, New York City, up to 1880, when there were 35 miles, is given by Mr. R. E. Johnston as follows:

Foundations, columns, superstructure and track.....	\$288,400
Stations	60,000
5 locomotives at \$4,000.....	20,000
12 cars at \$3,300.....	39,600
Total	\$408,000

The foundation pit is 7 ft. square and 7 ft. deep.

The foundation of each column is of brick 4x4 ft. on top and 6x6 ft. at the base, 4 ft. high, resting on two 6 in. flagstones, 3x7 ft. each, which in turn rest on 4 ins. of concrete.

The cast iron base of the column weighs 3,000 lbs. and is secured by four 2 in. bolts that pass through the foundation.

The longitudinal girders are 44 ft. long. Nothing was paid for damage to property.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Time Limits to Contracts and Penalties Thereon.

One of the most interesting papers read at the third biennial meeting of the American Public Works Association, held at Asheville, N. C., Sept. 29 and 30, was that of Mr. George A. King, attorney, Washington, D. C. Mr. King's paper was on time limits to contracts, and contained much information of interest to contractors. A full synopsis of Mr. King's paper follows:

In his paper Mr. King explained the technical meaning of a penalty, that is the statement of a sum of money intended only to secure the fulfillment of some obligation and creating what may be regarded as a sort of guaranty fund up to the amount of which the person injured may get damages, but not beyond, as contrasted with liquidated damages which is a certain amount which the parties have agreed upon as an estimate in advance of the amount of damages which will be sustained by the breach of the contract, as, for instance, the sum of \$20 or \$50 a day for non-completion of a building in time. This latter the courts usually regard as constituting liquidated damages which must be paid absolutely and at all events without regard to the exact damage which the party has actually sustained.

He summarized a number of interesting cases in which the courts had enforced with great strictness the provisions of contracts for the payment of liquidated damages. A curious instance occurred in England where the Clydebank Shipbuilding Co. was compelled to pay about \$300,000 time penalties to the Spanish government for failure to deliver a ship on time. It was to have been delivered at about the time of the outbreak of the Spanish-American war but by default of the contractors was not actually delivered until that war had ended. The company thought that the Spanish government had gained rather than lost by not getting possession of the ship which would inevitably have shared the fate of other Spanish vessels and been sent to the bottom of the ocean by the superior gunnery of the American navy. The English House of Lords which decided the case, took a very different view of the matter and held that as the company had agreed to pay certain damages for not delivering the ship on time, they must be held to the agreement and pay the damages whether the government of Spain had gained or lost by the delay.

Mr. King further stated that the strictness of construction which the courts have adopted in these cases does not by any means, however, always work to the advantage

of the person for whom the work is done. The builder or contractor has his rights. One of these is that the owner of the work must be ready to proceed and must put no obstruction in his way from beginning the work on time or from seasonably continuing it. A recent case in Mr. King's own practice in the Court of Claims was referred to as illustrative of this branch of the rule. A builder made an agreement, with the usual clause for liquidated damages, for a building for the use of the Quartermaster's Department of the Army. It required him to commence the work on or before a certain day and complete it by another. The contract provided that it was not to go into effect until approved by the Quartermaster-General of the Army. That officer did not approve it until 22 days after the date when the contractor should have begun to work. Here the court held that as the contractor was not under any obligation to begin the work until the proper officer had approved the contract, and that officer had delayed his approval, the government was in no condition to enforce any time penalties whatever. They held that to do so would be to make a new contract for the parties, and this although the contractor's delay in completing greatly exceeded that of the Quartermaster-General in affixing his approval to the contract.

Another case was referred to in which the contractor was to get a bonus for completion in extra prompt time—not to be subjected to a penalty for delay or failure to complete. Here the owner of the work had neglected to secure the necessary rights in a party wall, the work being performed in the city of London. The English courts held that the delay in getting the rights in the party wall having necessarily suspended operations on the part of the builder, he was thereby prevented by the owner's default from earning his bonus and the court allowed it to him accordingly, even though he had not complied with the literal terms of the contract.

Where owners of work order alterations, they generally lose thereby their right to impose damages for the contractor's failure to complete in time. The contractor agrees by the contract to perform the work described in the specifications within a certain time. If these specifications are altered for the owner's convenience, in such a way that the time involved is longer than that originally stipulated, his right to collect damages for failure to complete by the stipulated date is gone and as the courts cannot substitute a new date for that named in the contract, the result

is that he cannot collect any liquidated damages whatever. The utmost that he would be entitled to in such a case is the actual damages that he has sustained by the failure of the builder to complete on time.

Other and more complicated questions arise in the cases in which the original contract provides that alterations may be ordered by the owner and, if ordered, that they shall not dispense with or change any of the stipulations of the original contract. Even in such cases the courts hold that where an order for alterations necessarily requires more time to complete the altered work than the original work required, the necessary effect of the order is to extend the time for completion.

Sometimes the original contract not only provides for alterations to be ordered by the owner, but also provides that the engineer or architect shall determine the time necessary to make the alterations and shall grant an extension accordingly. In such a case, if the engineer orders alterations and also fixes the extended time for doing the work, his action is conclusive on the contractor. If, however, the alterations are ordered and no additional time given for making them, the contract has not been carried out by the owner or his engineer and the right to impose liquidated damages under the original contract is gone.

Questions also arise, which were discussed by Mr. King, as to the effect of one contractor on a building or engineering work being interfered with or delayed by some other contractor for another part of the work. These cases, to some extent, depend on their own circumstances and only the most general rules can be laid down in regard to them. The leading principle, however, is that the contractor is responsible only for his own defaults and delays and not for those of other contractors employed by the owner.

A proposition for a belt line freight sub-way for New York City, extending around practically the entire shore frontage of Manhattan island's business section, and including provisions for handling freight on a scale probably of greater magnitude than any yet provided in any of the world's great cities, has been filed with the Public Service Commission. The plan contemplates not only the main shore front sub-way of four tracks construction and electrically operated, but also branches extending into many cross streets, with provisions for connections with both trunk lines and branches, with piers, warehouses, and business houses.

The Chinese Government is to send two commissioners to investigate the methods of railway administration in the United States.

The city of Chicago is now calling for bids for erecting its new City Hall.

Method of Closing the Point Be Crevasse, Mississippi River, Louisiana.*

BY FRANK M. KERR.

The crevasse of which this paper treats occurred in the public levee on the Point Beka Plantation, in the parish of Orleans, on the west bank of the Mississippi River, about 15 miles, by river, below Algiers, opposite New Orleans. As the name, Point Beka, indicates, the river bank or batture along there is what is termed and known as a "making bank," and the public levee, located there many years ago, is some distance away from the river bank, as much as 1,000 ft., the batture or foreshore intervening between it and the river being densely overgrown with timber, brush, vines, etc.

The avenues of approach to and communication with the locality where the crevasse occurred were by way of the usual dirt road paralleling the public levee from Algiers down, and by the river. The first, owing to high water, seepage, etc., was slow, uninviting and impracticable for anything like active or extensive approach, and the second, owing to the distance of the levee from the river bank, the timber, etc., afforded no near landing places. No railroads, no telegraph, no telephone, were available. The river was, therefore, as a matter of course, promptly adopted as the most direct means of reaching the locality, one landing being established a mile and a quarter above and another a half a mile below the crevasse.

The levee line at Point Beka, averaging about 10 ft. in height, presented, on the surface, a very good appearance, grade well above the high waters of the past, crown some 8 ft. wide, flat slopes averaging 3 and 3 to 1, and all clean and well turfed. It was, however, known to be infested with crayfish and had become so honeycombed by them as to require constant attention during high water, and the construction from time to time of numerous "mud-boxes," tentative cofferdams, as it were, to surround the apparently worse places in the line. It was at one of these "mud-boxes," constructed a year or so before, that the breach occurred. The crayfish had, no doubt, so chambered the embankment there as to leave it a mere shell, which, notwithstanding the reinforcement attempted by means of the "mud-box," succumbed to the severe pressure of the high stage of water against it.

The break occurred at about 7 o'clock, June 6, during the period of high water in the Mississippi River this season, developing a width of about 30 ft. by 2 o'clock that evening. Steps were the same day promptly taken by the Orleans Levee Board—the local organization charged with the care, preservation and maintenance of the levees in the Orleans Levee District—to close the break, but without success, the work at-

tempted failing on the night of the 9th, and further efforts were suspended pending developments. After a couple of days' consideration, however, it was determined to make another attempt to close the crevasse, and preparations were at once made to do so.

By June 12 organization was effected and the filling of sacks and the construction of the cribbing begun. This was carried on uninterruptedly day and night in spite of much inclement weather, and the cribbing completed by noon on the 20th. Sacking followed within an hour after the completion of the cribbing, and by 6 o'clock the next morning, Sunday, the 21st, the flow through the crevasse, with the exception of the usual leakage common to such work, was checked, the territory back of the breach becoming rapidly relieved of overflow.

The construction of the "mud-box" around the cribbing, with further sacking and the trimming up of the cribs to provide for shrinkage and settling, came next, and the work in its entirety was satisfactorily completed by the 25th, no cause for further anxiety for the locality having since developed.

By the time the second attempt to close the crevasse had gotten well under way, the width of the breach in the levee had grown to about 100 ft., beyond which it increased but little up to the closure, being then found by measurement to be 109 ft. wide, the upper and lower wings of the work constructed during the first attempt to close the crevasse remaining intact and acting as permeable spurs or dikes, proving an invaluable aid in protecting the exposed ends of the levee from further material loss.

The channel or "gulch" through the levee averaged some 50 ft. in width and from 18 to 20 ft. in depth below the natural surface of the ground, and extended from a point about 150 ft. on the river side of the levee to a point some 250 ft. on the land side of the levee. There was neither time nor opportunity nor means of accurately ascertaining the velocity of the current through the break, but it could not have been less than ten miles an hour, and, at times, was possibly as much as fifteen.

Not a single method was adopted or used in closing this crevasse not already fully known to any one familiar with such work. Nothing new whatsoever. Just the same old "git-up-and-git" tactics followed by the "Old Timers" of Bayou Lafourche and the Lower Coast in days gone by, only on a much larger and more elaborate scale, and conducted with more system, formulation and deliberation than was possible or needed in olden times.

The most important initial factor in the work of controlling crevasses is an intimate knowledge and appreciation of what one is "up against"; next, organization, dispatch and attention to detail. Time is "king," and will be so recognized—no flurry, or hurry, or worry. Not one mo-

*A paper read before the Louisiana Engineering Society July 13, 1908, and printed in the Journal of the Association of Engineering Societies for August, 1908.

ment, however, must be lost in being up and doing, while all question of dollars and cents, that is, cost, must be lost sight of.

Organization means the preparation of bills of material, establishing lines of transportation; depots for receiving materials and supplies; housing and feeding employes and laborers, for day and night shifts; securing a proper division of labor, both superior and inferior, by the establishment of departments, including the selection of proper persons to fill positions, whether superior or inferior, and last, though not least, the direction over all by one general supervisor, whose will and word shall be law.

At Point Beka the greatest drawback was its inaccessibility and the absence of any direct and prompt means of communication with the point of supply, New Orleans. As already explained, the nearest means of direct approach was by river, at landings one and one-quarter and one-half miles, respectively, above and below the breach. From these landings everybody engaged upon the work had to pass to and fro, and everything needed upon the work had to be transported either by hand, by wheelbarrows, trucks and sleds drawn by mules, along the narrow ribbon of earth afforded by the levee, or by small barges or pontoons cordelled along the side of it, the country on both sides of the levee being but little more than about three feet above the surface of the water.

Large barges, as depots for materials and supplies, and quarter boats for housing and feeding the employes and laborers, were located at the landings above described, with headquarters in a hastily constructed "shack," as near the breach as safe and practicable. An attempt was at first made to establish a telephone station at "headquarters," but it was found to be an impracticable undertaking, there being no circuit on that side of the river nearer than six miles. However, a station was later secured at a point on the opposite side of the river, which, in connection with a dispatch boat (gasoline launch), did excellent service.

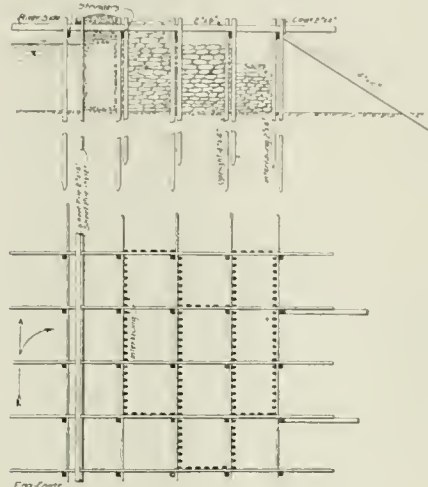
Perhaps the next thing of interest would be some little insight into the bills of materials, transportation and supplies, etc., called for.

Well, here was the first order, followed, from day to day, by many others: *Materials:* 215,000 ft. B. M. lumber; 65,000 sacks, with twine and needles to suit; 50 kegs of wire nails, 20d., 40d. and 60d.; 50 bales of rice straw; 4 coils of $\frac{5}{8}$ -in. manila rope; 4 large tarpaulins; wheelbarrows, long and short handle spades, hand mauls, top mauls, axes, hatchets, adzes, hand and cross cut saws, trucks, gasoline torch lamps, lanterns, locomotive head lights, pine knots, insurance oil, gasoline oil, etc., all "galore." *Transportation:* 2 large harbor tug boats, 1 large model deck barges, 2 large covered barges, 20 small barges or scows, 10 skiffs

and 1 large model quarter boats. *Assistants and labor:* 1 general superintendent of labor and supplies, with full authority to make requisitions for everything necessary for the general comfort and feeding of the whole force on the ground, with as many foremen, stewards, cooks, waiters, scullions, etc., as he deemed necessary; two assistant engineers; four superintendents of sacks; four superintendents of lumber orders; four bridge foremen, with full complement of men for crew for each; and last, but not least, a daily average of about five hundred laborers.

And now about construction. Though very simple, it is difficult to describe it.

The object sought is to subdue the energy of flow by degrees, but with sufficient dispatch to subject the bottom upon which



Plan and Section of Cribbing.

the structure rests to as little scour as possible. Therefore after selecting the route to be followed by the structure, a skeleton, consisting of uprights, stringers and cross pieces, is built around the breach along the route selected, preferably on the river side of the levee in which the breach exists. The uprights are spaced longitudinally and transversely, as conditions and circumstances demand. In the structure at Point Beka, the uprights, 4 in. by 4 in., were spaced 4 ft. from centers each way, the stringers and cross pieces being composed of 2 in. by 6 in. Next, the spaces, formed by the rows of uprights, stringers and cross pieces, are interlaced longitudinally and transversely, as shown on plan, with other uprights, usually, as at Point Beka, 2 in. by 4 in., spaced 6 in. between centers longitudinally, and 8 in. between centers transversely, with the narrower face always against the current. The result is a series of cribs breaking joints, as it were, as shown on plan, about 4 ft. wide and 12 ft. long. At Point Beka, the 4 in. by 4 in. uprights were given a penetration of about 8 ft., driven to an elevation about 3 ft. above the water, and the longitudinal stringers were nailed to the uprights, at an elevation of about 2 ft. above the water, with the cross pieces,

also nailed to the aprights, immediately above and resting on the longitudinal stringers. The 2 in. by 4 in. interlacing was given about the same penetration as the 4 in. by 4 in. aprights, and driven down as nearly flush with the longitudinal stringers and cross pieces as practicable. All the piling—uprights—was driven by hand pile-drivers, more commonly known as "babies or dollies." Bracing the structure then followed. At Point Beka this was very simple. A piece of 4 in. by 1 in. driven into the ground on the land side, on a slope of about 3 to 1, fitted and nailed to every other 4 in. by 1 in., with a stiff cleat fitted and nailed above the head of the brace. This quickly adjusted form of bracing is preferable to any kind of interior bracing, as it in no way interferes with the sacking or with the settling of the sacks, as the other is more than apt to do.

As soon as the interlacing is completed, sacking is begun, a sufficient number of sacks to insure no interruption in the progress of the work having in advance been filled and securely closed and sewed up. Right here it should be stated that the sack should not be filled too full, only about three-quarters full, to allow for pliability, to induce adjustment to inequalities; and that the thorough tying and sewing of the sacks is very essential. The sacks, of course, were filled with earth borrowed from the levee above and below the breach. The cribs along the land side of the structures are the first to be sacked from end to end. Sacks sufficient only to thoroughly floor these cribs, and to correct any differences of level in the floor, are at first lowered into them. Then the next row of cribs is sacked, from end to end of structure, to a somewhat higher elevation than the first, and the next still higher, until the last row of cribs facing the river side of the structure is reached, in which row of cribs the sacks are brought up to an elevation just above the surface of the water in the river. Then more sacking continues, uninterruptedly, of course, until a safe elevation in each row of cribs is reached, and the flow through the structure is checked, or rather coaxed into submission. Just here a word of explanation about that item of "hay" in the first bill of material mentioned. This is gathered from the bales, by the handful—just the handful—and scattered in the cribs, among the sacks, during the process of sacking, to be borne by the current into the small interstices occasionally occurring between the sacks, and thus temporarily assist in checking small leakages, as may be readily understood.

By the way, too, sacking does not consist of dumping sacks pell-mell, helter, skelter into the water. Not by any means. Each sack should be taken from the shoulder of its carrier and lowered into the water by men assigned to that duty. At Point Beka, a large proportion of the sacks were filled at considerable distances from the cribbing and had to be handled several times before reaching it,—by hand, by

wheelbarrows, by sleds drawn by mules and by pontoons cordelled along the levee.

After sacking, the construction of the "mud-box" along the river side of the structure follows. This is usually, as at Point Beka, made about 3 ft. wide, the river wall of the box consisting of a double row of sheeting piling, 2 in. by 12 in., and 1 in. by 12 in., breaking joints,—the 1 in. by 12 in., on the inner side of the wall,—driven to an elevation about 2 ft. above the water in the river, about 3 ft. into the ground, and nailed to a horizontal stringer, 2 in. by 1 in., secured to the cross pieces and uprights, with the cribbing and sacks constituting the land side wall of the box. The box is finally filled up with earth, effectually cutting off all flow, that is, when the structure proves successful.

The form of the structure around the breach was in the shape of a succession of tangents inscribed upon a semicircle having a radius of about 200 ft. The route followed was selected after a careful survey of the batture or foreshore and the depth of water over it, and determined by depth of water, character of bottom and clearings in the timber and brush,—the shallower the water and the clearer the course, the better, as a matter of course. The length of the structure was 71 ft.

Very few mishaps in construction occurred at Beka. Shortly after the work was first completed, some half a dozen "boils" developed on the land side of the structure, two of which, where it crossed old borrow pits, proving for a while quite serious. All were, however, finally successfully treated, and the work as a whole declared, by all who saw it, to present a thoroughly substantial and workmanlike appearance. The total cost of the work performed, under the direction of the writer, was about \$37,500. The damage to property and crops resulting from the crevasse was purely local, probably not exceeding \$50,000 actual value. Had the crevasse not been so promptly closed, however, it would beyond doubt have widened and deepened to such an extent as to affect a very large extent of country and to cause damages reaching into the hundred thousands.

Finally, it might be well to say that the gage at New Orleans, at the time of the closure of the crevasse, recorded a stage of 19.8 ft., that is, within a half a foot as high as the highest water of record there. At the same time, too, the water was still rising, reaching the maximum stage for this year, 1908, 20 ft., the day after the closure of the crevasse, or only 0.3 ft. lower than the highest water of previous record. With this stage, the head of water against the completed work stood from 6 to 9 ft.

The Yellowstone National Forest has been divided into three divisions: The Tague national forest, the Wyoming national forest and the Teton national forest. Each has been put in charge of a supervisor.

LETTERS TO THE EDITORS

Checking Levels.

Sirs: I have noted articles published in the recent issues of "our journal" relative to checking levels, but have noticed no mention of the method sometimes used in this section which consists of running check levels simultaneously with the regular levels. It is in brief the use of double turning points of different elevations; e. g., in running levels over a staked line, at the "peg," a reading is taken on the ground and one on top of the stakes and after the instrument is moved forward, readings are again taken on the ground and stake, either of which may be the turning point and the other the "check." This method is best used where the level man takes all the readings himself without the use of a target rod, although it is equally applicable in the latter case. Specimen notes are herewith shown:

Station.	B. S.	HI.	FS.	Elv.
B. M.	3.40	103.40	...	100.00
CK .....	...	.....	2.10	101.30
T. P. ....	...	.....	1.25	102.15
.....	5.00	107.15	...	.....
CK .....	...	.....	5.85	101.30

It will be noticed that at each turn a reading is first taken on the "check," then on the "T. P.," and again on the "check" before proceeding with the regular levels.

I should like to see a discussion of the various systems used in assessing benefits derived by county drainage districts and of the durability of cement drain tile, as undoubtedly many of your readers are interested in these subjects.

Lake City, Ia. A. O. ANDERSON.

The Waterproofing Value of Alum and Clay as Concrete Ingredients.

Sirs: I have read with interest the results you publish of a series of tests by H. W. McGee, Engineer Maintenance of Way, Ulster & Delaware Ry., to determine the waterproofing value of alum and clay as ingredients of concrete. Without desire to comment on these experiments, it is necessary that attention be called to an error in the original paper on Waterproofing Concrete, communicated by me to the American Society of Civil Engineers, July 30, 1907. In the hurried preparation of the paper as a portion of discussion for the 59th volume of the Transactions, it was stated that water tight concrete may be obtained by replacing from 5 to 10 per cent of the cement with an equal quantity of dried and finely ground colloidal clay, intimately mixed with the cement. Instead of this, I meant to state that water tight concrete could be obtained by replacing from 5 to 10 per cent by weight of sand with an equal quantity of finely ground colloidal clay, intimately mixed with the cement. While Mr. McGee's tests throw some light on the effect of replacing cement with clay, his results cannot be considered as comparable with ours, since in the

experiments conducted here, given proportions of sand alone were replaced by clay.

Recent laboratory tests here with properly selected and prepared clay have fully confirmed our published results of a year ago, with uniformly increased strength and practical impermeability under ordinary pressures, both in mortars and concretes. In fact, apart from the waterproofing effect, the increases in tensile and compressive strengths have been such as to apparently justify the recommendation of additions of clay for strength alone.

Continued experiments with alum and other salt solutions have given results that were variable and inconclusive.

New York. RICHARD H. GAINES.

Cost of Cutting Cord Wood and a Record Day's Work.

Frequently a contractor must figure on using wood for fuel, in which case it is desirable that he know the cost of cutting and piling cord wood. The following average record relates to work done in the State of Washington under the direction of one of the editors of this journal. The work involved the felling of the trees, which were fir, sawing them into cord-wood lengths (4 ft.), splitting and piling. Axmen averaged 2 cords per 10-hour day, but an extra good woodman will readily average 3 cords per day. With wages at \$2.50, a cord of wood cost \$1.25 ready for hauling.

A cord measures 128 cu. ft., of which about 65% is solid wood, the remaining 35% being the voids or spaces between the sticks. Washington fir when green weighs about 3.5 lbs. per ft. B. M., and about 3.2 lbs. when dry. Hence a cord of green fir weighs about 3,200 lbs., or 1.6 tons, which is a good wagon load on most roads. About 10 cords is the ordinary carload.

In our issue of Sept. 2 we gave the amount of coal or wood consumed daily by contractor's boilers of different sizes.

The daily papers of Sept. 27 contained an Associated Press dispatch from which we have abstracted the following record of wood chopping on a wager. A Vermont woodsman undertook to cut down, chop up, split and pile 5 cords of bass wood between sunrise and sunset. He did it, with nearly an hour and a half to spare, for he had completed his work in 10 hours, and had half a cord of unsplit wood left over. The trees ranged in length from 60 to 70 ft. and were 9 to 13 ins. diameter at the butt. At the end of 4 hrs. and 40 mins. he had felled 18 trees and had chopped and split 3½ cords. It took him about 2 hrs. and 40 mins. to pile the 5 cords.

This record is said to be the best ever made. It is interesting to note that this man's output was about double what is regarded as a good day's work, and, in this respect, the record bears out the generalization that a man can perform on a wager about double the physical work that he is accustomed to do day in and day out.

work which were developed in the above named surveys. Drawings of a field sketching table, a special stadia rod and an illuminated target for use in making polaris observations are given. A method was devised which eliminates errors in observation by arranging the order and number of observations in such a way as to make each step a check on the next step. This method is described.

Precise Level Operations on the Los Angeles Aqueduct. By C. H. Lee, Eng. News, Sept. 17, 1908; 1½ pp.

Describes the instruments used and the methods of work employed in running precise levels and setting bench marks for the 235 mile conduit named. A calculation is made of the effect on flow of errors in leveling and a summary of the cost of the leveling operations is given as follows:

Cost per mile of completed levels.....	\$13.20
Cost per mile of all levels run.....	8.70
Cost per bench.....	24.00

A Practical Drawing Office System, II. By A. T. Evans, Am. Engr., September, 1908; 5 pp.

This is the second part of Mr. Evans' article on the drafting room practice of the Canadian Pacific Ry., the first part of which was reviewed in the monthly Review Index for July 1, 1908. In this article the author discusses: maintenance regulations, changes and revisions, distribution of blue prints, material tests for new equipment, changes in progress and receipts for blue prints.

COST KEEPING AND MANAGEMENT.

Purchasing Records for Contractors. By E. A. Worden, Constructor, Sept. 1, 1908; 2 pp.

Describes, with sample cards, a system for recording the purchase of materials. The method of operating the system is fully described and the general advantages of purchasing systems are discussed.

The Valuation of the Property of Public Service Corporations. Eng. Rec., Sept. 5, 1907; 1 p.

From an address by Henry L. Doherty before the Wisconsin Gas Association. Elementary points are made for consideration, and items for valuation are listed in making up estimates of cost and value. Some comments are made on the different items. Article of general interest on this subject.

MISCELLANEOUS.

Different Power Costs for Steam Driven Compressors. Comp. Air, September, 1908; ¾ p.

Abstracted from a series of papers on cold storage in the Cold Storage and Ice Trade Journal, by Chas. D. Havenstrite. Shows the difference in fuel cost of operating a slide valve engine, a simple Corliss and a compound condensing Corliss in running an air compressor. Comments are made on the engine to be used for varying H. P. needed and under different conditions.

Garbage Disposal at McKeesport. Mun. Jl. & Eng., Sept. 16, 1908; ½ p.

Describes briefly municipal garbage disposal plant at McKeesport, Pa. Principal feature is description of simple apparatus for sterilizing garbage cans. This consists of two perforated rings of pipe about 12 in. apart connected to an upright pipe. Hot water is applied to these from a tank and the cans placed inverted over this contrivance.

Richmond Borough Refuse Destructor. Mun. Jl. & Eng., Sept. 30, 1908; 5¼ pp.

A general description of the West New Brighton refuse destructor of the Borough of Richmond, New York City, together with a summary of the official tests made preliminary to the acceptance of the plant from the contractor.

Convict Labor in Illinois. By A. N. Johnson, Gd. Rds. Mag., September, 1908; 1¼ pp.

An address before the National Convict

Labor and Good Roads Convention, Grand Rapids, Mich., July 23, 1908. Describes mainly the use of prisoners for operating the stone crushing plants at the two state prisons in Illinois and gives full text of the law under which this stone is furnished free to township highway commissioners.

Hours and Wages of Common Labor in 1907. Eng. Contr., Sept. 30, 1908; ¼ p.

Table showing the average hours worked and average wages per hour for common labor in contract work for street and sewer construction in 54 leading cities of the United States.

The New Ore and Coal Handling Dock of the Pennsylvania Company at Ashtabula Harbor, Ohio. Eng. Rec., Sept. 12, 1908; 5 pp.

An extensive account of the improvements made by this railroad for handling ore. Illustrated with a number of photographs and a plan of the track arrangement, also of the ore handling machinery.

The Pennsylvania Railroad Forest Nursery. Eng. Rec., Sept. 5, 1908; 1½ pp.

A description is given of the new nursery for raising forest trees at Morrisville, Pa. Trees are being raised for tie and timber purposes as well as for ornamental uses. The nursery was established about a year ago.

Some Notes on Japanese Engineering. By James D. Schuyler, Eng. Rec., Sept. 26, 1908; 2 pp.

Gives an account of some engineering methods used in Japan as to revetment, dike work and small suspension bridges.

The Effective Efficiency of Coal in Steam Plants. By D. B. Waters, Min. Sci., Sept. 17, 1908; 2 pp.

In this article the author discusses power in coal; boiler efficiency and steam engine efficiency, being an analysis of steam plant conditions, showing causes for losses in efficiency.

Waterproofing the Land Sections of the Detroit River Tunnel. By S. H. Opdyke, Eng. News, Sept. 24, 1908; 1 p.

Reprints expenditures for waterproofing concrete lining with general description of the method of doing the work.

Labor Cost of Constructing 74 Brick Vaults for Underground Conduit. Eng.-Contr., Sept. 23, 1908; 1½ pp.

The vaults were constructed for telephone conduit and were of three sizes and styles. Methods of construction are briefly described, wages and organization studied and labor cost in details given for each vault.

Estimating the Horsepower of Contractor's Engines and Boilers. Eng.-Contr., Sept. 2, 1908; ½ p.

Gives rules for calculating the horsepower of engines and of boilers, with explanation of the data required for estimating.

Methods and Cost of Laying 6-in. and 8-in. Wrought Iron Screw Joint Pipe for Compressed Air Main. Eng.-Contr., Sept. 9, 1908; 1 p.

The work comprised 7,000 ft. of 6-in. and 4,000 ft. of 8-in. pipe. Methods of work, gang organization and special tools employed are described. Itemized costs are given for both sizes of mains with full details of conditions governing costs.

Subway Manholes. Mun. Jl. Eng., Sept. 16, 1908; ½ p.

Illustrates and describes briefly a special type of manhole used in conduit work at Auburn, N. Y. The manhole is divided into two compartments by a wall for high tension and low tension wires.

Time Penalties on Contracts. By George A. King, Eng. Rec., Oct. 3, 1908; 3 pp.

A paper read before the American Public Works Association. It discusses liquidated damages and penalties, and time limits on engineering contract work, giving various illustrations of court decisions on such matters and sets forth clearly the results of such

decisions. Some recommendations are made as to framing clauses bearing on liquidated damages and time penalties.

Raising and Supporting a Gas Holder. By W. R. Phillips, Eng. Rec., Oct. 3, 1908; 1½ pp.

Describes the aligning and raising of a gas holder that had become useless from a poor foundation. Details of the methods of the work are described.

Raising an Elevated Railroad Structure Under Traffic. Eng. Rec., Oct. 3, 1908; 1½ pp.

Describes the method used in raising an elevated railroad in Chicago in preparing for the passenger terminal improvement of the Chicago and Northwestern Ry.

BOOK REVIEWS.

Water Powers of Georgia.—By B. W. Hall and M. R. Hall, Bulletin No. 16, Geological Survey of Georgia. S. W. McCaille, State Geologist, Atlanta, Ga. Cloth, 6x9 ins.; 425 pp.

This is the second report issued on the water powers of Georgia. The data were collected by co-operative work of the geological survey of the state and that of the National government. It includes the principal rivers of the northern part of the state, and both the developed and the undeveloped water powers. The discharge and the gage height as well as a rating table of the various streams are given. A map shows the rivers upon which these records have been made, and the location of the gaging stations. The book is illustrated by excellent half tone reproductions of some of the streams, dams and waterfalls.

Manual of Reinforced Concrete and Concrete Block Construction. By Charles F. Marsh, M. Inst. C. E., M. Am. Soc. C. E., and William Dunn, F. R. I. B. A. New York. D. Van Nostrand Co. Flexible leathers, 4¼x6½ ins.; pp. 290; illustrated; \$3.

This is a pocket book for designers and builders in concrete. It is the first such manual to deserve serious consideration, other previous pocket books either bearing the stamp of trade production or being limited in their scope. The authors have gained a reputation as the writers of one of the most comprehensive and the only important one of the British treatises on reinforced concrete; they, therefore, come well prepared for their new work. At first glance the pocket book, like the authors' larger treatise, seems too peculiar to European practice to be of most use to American readers, but this impression is removed to a great extent by a full reading. The tables and diagrams are calculated on the basis of the recommendations of the Reinforced Concrete Committee of the Royal Institution of British Architects which of course limits their practical influence as aids to computation so far as American engineers are concerned. The majority of the "calculations" which make up the greater bulk of the book, are, however, of general application and many of them are based on the studies and practice of American engineers. Altogether the portions of the work on reinforced concrete are valuable. The section on hollow concrete blocks is rather inadequate. The book is divided into the following sections: Materials; Construction; Waterproofing and Fire Resistance; Loads; Bending Moments, etc.; Calculations; Hollow Concrete Blocks; Tables, Diagrams, and General Information.

Engineering Works in Towns and Cities.—By Ernest McCullough, C. E. Chicago and New York; the Myron C. Clark Publishing Co. Cloth, 5¼x8 ins.; pp. 502, illustrated; \$3.00 net.

The present edition of this unique manual has been revised and rearranged and much new matter has been added. Its usefulness to the class of readers for which it is writ-

ten has thus been materially increased. The book is confined to the problems of engineering in towns and cities. It can be called a manual of city engineering. In this respect it is unique. Numerous books treating individually of water works, sewerage, paving, etc., etc., have been written for city engineers, but so far as we know this is the only book treating of all of these subjects in the relation to each other in which they come before the city engineer, and before the commissioner of city works, the mayor and the councilmen. We mention this last fact because to our mind one of the valuable features of the book is that it discusses these problems of city engineering work in a manner that makes them quite as interesting and clear to the city officials not engineers as to the city engineer himself. Another general feature of the book that deserves notice before we consider its separate parts in detail is that the execution of city works is considered as well as their planning and theory. In this respect the book is again unique among books for city engineers. So much for the general character of the book.

The author has divided his subjects into fourteen chapters, as follows: The City Engineer and His Duties; Roads and Streets; Walks, Curbs and Gutters; Street Pavements; Sanitation; Drainage and Sewerage; Water Supply; Concrete; Contracts and Specifications; Miscellaneous Data; Office Systems; City Engineers' Records; Field Work, and Engineering Data. This schedule of chapter titles gives a fair idea of the scope of the book; it fails wholly, however, in giving an adequate idea of the extent of its contents. The compact make-up and the small type enable the author to get an unusual amount of matter into a moderate space.

The method of treatment in each chapter is, briefly stated, to explain the theory and purpose of the work, then to explain its proper planning and finally to discuss and describe its execution. Examples of actual structures are shown to illustrate the statements made and complete specifications are shown for all classes of work. The chapters on office systems and on city engineers' records are particularly complete in examples and illustrations of filing systems, and indexes, record blanks, notebook forms, and all the time saving and accuracy securing devices and methods so essential in a city engineer's work. These chapters and those on field work and on engineering data are specifically for the city engineer; the remaining chapters will be understood and appreciated by the non-technical city official as well as by the city engineer.

In closing, we cannot but express our regret that information of the character contained in this book is not, and apparently cannot, be got before the citizen, the voter and the taxpayer. Aside from the sections specified above there is very little in Mr. McCullough's book that cannot be read understandingly by both the business and the professional man. Could they but read it the city engineer's burden would be vastly lightened.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell

us and we will notify promptly the leading manufacturers.

No. 0909. **Reinforced Concrete.**—Concrete Interlocking Steel Corp'n., 43 Exchange Place, New York.

A bulletin setting forth the merits of the du Mezuel system of reinforcing concrete with corrugated sheet steel, that can be adapted to all kinds of concrete construction. The many claims of superiority are set forth, and diagrams are given showing the safe loading of slabs with this style of reinforcement.

No. 0910. **Water Proofing.**—The U. S. Waterproofing Co., St. James Building, New York.

A 12-page pamphlet telling of the advantages of Wunner Bitumen-Emulsion for waterproofing cement, concrete and stone. Mixed with mortar it is applied to the work either during or after construction. Directions for preparation and application are given. Also results obtained with this method of waterproofing are listed.

No. 0911. **Wood Blocks.**—The Wyckoff Pipe & Creosoting Co., 50 Church St., New York.

A 16-page pamphlet entitled "The Modern Pavement for Streets and Bridges," devoted to setting forth the merits of the Wyckoff creosoted wood block. These blocks are distinguished from others, so the manufacturers state in many ways, the two principal ones being, that they are all the same size and all are saturated with creosote.

No. 0912. **Teredo Proof Paint.**—The Tere-do-Proof Paint Co., 17 Battery Place, New York.

This 16-page catalog tells of the use of Kennon's Teredo Proof Paint for marine use and wood preservation. The paint is applied hot and protects the wood from rot and against the ravages of sea boring insects and animals. Much valuable information regarding the use of this paint is given, and also testimonials regarding its successful use.

No. 0913. **Steel Flumes.**—T. C. Egleston, 714 Ideal Building, Denver, Col.

A 32-page catalog of the Maginnis galvanized steel flume, showing it in successful use in various parts of the west. This flume is made in various sizes and is used for power, mining and irrigation purposes. Many advantages are claimed for it over wooden flumes, one being that the steel flume does not leak. The catalog shows how the flume is put together, and method of erecting bents and carrying it across gulleys and along mountain sides.

No. 0914. **Reinforced Concrete.**—Leibu Hermann, 11 Broadway, New York.

An 8-page folder describing the Hermann system of concrete steel floor construction, which is claimed to save from 4 to 12 cts. per square foot of floor surface over any other type now in use. It is a panel construction, consisting of a flat slab supported by columns and beams so that the ceiling is divided by the beams into square or rectangular panels.

No. 0915. **Steam Shovels.**—The Vulcan Steam Shovel Co., Toledo, Ohio.

A leather bound 120-page book describing the various styles and sizes of the steam shovels manufactured by this well known company. Many half-tone cuts show the shovels at work, thus indicating their adaptability for different kinds of excavation. Besides this large catalog, the Vulcan Steam Shovel Co. issues a number of smaller catalogs, each devoted to a separate class of shovels, known under various heads, as Heavy Duty Steam Shovel; Shovels for Digging Trenches; The Revolving Shovel; the Electric Shovels and some half dozen other headings. These small pamphlets give dimensions and complete specifications of each style, size and type of shovel made.

No. 0916. **Concrete Piles.**—Raymond Concrete Pile Co., 140 Cedar St., New York.

This 22-page catalog of standard size 6x9 ins., is handsomely printed and is descriptive of the Raymond system of concrete piling. The method of making and placing these piles are shown, and a comparison of the use of concrete and wooden piles is made. Specifications for concrete piles are given, and a list of some of the users of the Raymond pile completes the catalog.

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Expert Designer and Inspector of Bridges
Citizens Building Cleveland, Ohio

Rock Excavation

Methods and Cost

By

HALBERT P. GILLETTE,

M. Am. Soc. C. E. Editor "Engineering-Contracting."

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The Cost of Machine Drilling.
Cost of Diamond Drilling.
Explosives.
Charging and Firing.
Methods of Blasting.
Cost of Loading and Transporting Rock.
Quarrying Stone.
Open Cut Excavation.
Methods and Costs on the Chicago Drainage Canal.
Cost of Trenches and Subways.
Subaqueous Excavation.
Cost of Railway Tunnels.
Cost of Drifting, Shaft Sinking and Stopping.

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And Its Cost

By

HALBERT P. GILLETTE,

M. Am. Soc. C. E. Editor "Engineering-Contracting."

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Earth Classification.
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Cost of Dumping, Spreading, Rolling.
Cost of Wheelbarrows and Carts.
Cost by Wagons.
Cost by Buck and Drag Scrapers.
Cost by Wheel Scrapers.
Cost by the Elevating Grader.
Cost by Steam Shovels.
Cost by Cars.
How to Handle a Steam Shovel Plant.
Summary and Table of Costs.
Cost of Trenching and Pipe Laying.
The Cost of Hydraulic Excavation.
Cost of Dredging.
Miscellaneous Cost Data.
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Cost of Operating.

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CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

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Bridges.

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Oct. 9. Fort Gaines, Ala.....	Wharf, Sea Wall, Sept. 16
Oct. 12. Reading, Pa.....	Garbage Removal, Sept. 30
Oct. 12. New York, N. Y.....	Electrical Work, Oct. 7
Oct. 13. New York, N. Y.....	Garbage Disposal, Sept. 30
Oct. 13. Marion, Ind.....	Electric Light Plant, Oct. 7
Oct. 13. Chicago, Ill.....	Conduit System, Oct. 7
Oct. 14. Bangor, Me.....	Removing Wreck, Sept. 23
Oct. 15. Chicago, Ill.....	Wooden Platform, Oct. 7

Oct. 17. Norfolk, Va.....	Wharf, Etc., Oct. 7
Oct. 20. Oneonta, N. Y.....	Street Lighting, Sept. 30
Oct. 21. Chicago, Ill.....	Foundation Work, Oct. 7
Oct. 26. National Soldiers Home, Penn.....	Flagstaff, Oct. 7
Nov. 2. Washington, D. C.....	Submarines, Aug. 6
Nov. 17. Mobile, Ala.....	Lock and Dam, Sept. 23

Excavation, Earth and Rock.

Oct. 8. Cerro Gordo, Ill.....	Ditch Work, Sept. 16
Oct. 8. Woonipeg, Man.....	Filling, Sept. 30
Oct. 9. Walnut, Ill.....	Ditch Work, Sept. 23
Oct. 9. Port Arthur, Ont.....	Dredging, Oct. 7
Oct. 10. Carthage, O.....	Grading, Drains, Sept. 23
Oct. 10. Elbow Lake, Minn.....	Ditch Work, Sept. 23
Oct. 10. Oregon, Mo.....	Ditch Work, Sept. 30
Oct. 10. Memphis, Tenn.....	Levee Work, Oct. 7
Oct. 10. Fowler, Ind.....	Ditch Work, Oct. 7
Oct. 12. Red Lake Falls, Minn.....	Ditch Work, Sept. 30
Oct. 14. Chicago, Ill.....	Rock Excavation, Sept. 16
Oct. 14. Brooklyn, N. Y.....	Dredging, Oct. 7
Oct. 14. Vicksburg, Miss.....	Levee Work, Oct. 7
Oct. 20. Peterboro, Ont.....	Canal Work, Oct. 7
Oct. 21. Crookston, Minn.....	Ditch Work, Sept. 30
Dec. 1. Hawaii.....	Dredging, Sept. 23

Materials, Machines, Supplies, Tools, Etc.

Oct. 7. Washington, D. C.....	Cranes, Sept. 16
Oct. 8. Boston, Mass.....	Junction Boxes, Cable, Sept. 16
Oct. 8. Nat'l Soldiers Home, Tenn.....	Cement, Stone, Etc., Sept. 23
Oct. 8. New York, N. Y.....	Portland Cement, Sept. 30
Oct. 8. Kansas City, Mo.....	Pipe, Sept. 30
Oct. 8. Scranton, Pa.....	Garbage Wagons, Oct. 7
Oct. 9. Columbus, O.....	Book Stacks, Oct. 7
Oct. 10. Boston, Mass.....	Boilers, Etc., Sept. 23
Oct. 10. Chicago, Ill.....	Line Wire, Sept. 30
Oct. 10. Ft. George Wright, Wash.....	Track Scale, Sept. 30
Oct. 10. Fessenden, N. Dak.....	Gasoline Engine, Oct. 7
Oct. 12. Washington, D. C.....	Derricks, Hoisting Engines, Etc., Sept. 23
Oct. 12. Los Angeles, Cal.....	Motor, Electric Locomotives, Etc., Sept. 30
Oct. 13. Chicago, Ill.....	Electric Light Wire, Oct. 7
Oct. 14. Vancouver, B. C.....	Pipe, Aug. 19
Oct. 14. Richmond, Va.....	Pipe, Etc., Sept. 23
Oct. 15. Brownwood, Tex.....	Pumping Machinery, Oct. 7
Oct. 15. New York, N. Y.....	Broken Stone, Oct. 7
Oct. 16. Washington, D. C.....	Clam Shell Dredges, Sept. 23
Oct. 16. Soldiers Home, Cal.....	Motor, Dynamo, Sept. 30
Oct. 17. Washington, D. C.....	Cranes, Oct. 7
Oct. 19. Houston, Tex.....	Pumping Engine, Sept. 23
Oct. 19. Washington, D. C.....	Rock Crushing Plant, Sept. 30
Oct. 28. Fort Sam Houston, Tex.....	Electric Elevator, Oct. 7
Nov. 2. Chicago, Ill.....	Generators, Pumps, Boilers, Etc., Oct. 7

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Marianna, Ark.—Until Oct. 8, by W. T. Derleek, County Judge, for building bridge 250 ft. long and from 5 ft. to 12 ft. high on new road west of Merd.

Oakland, Cal.—Until Oct. 12, by County

Supervisors, John P. Cook, Clerk, for constructing concrete arch bridge over Mission Creek.

San Bernardino, Cal.—Until 11 a. m., Oct. 26, by County Supervisors, for the construction of a bridge over Mojave River, north of Barstow. The bridge will have a total length of 200 ft. center to center of end piers and consists of one through pin connected 10-panel truss bridge resting on concrete bulkheads.

Jacksonville, Fla.—Until Oct. 30, by C. Benedict, Chairman, for erection of two bridges on Talland Road.

Brookville, Ind.—Until 2 p. m., Oct. 9, by Chas. A. Miller, County Auditor, for constructing two arch bridges and approaches.

Indianapolis, Ind.—Until 10 a. m., Oct. 8, by Albert Sahn, County Auditor, for constructing following: Bridge over Doe Creek, Franklin Township; high truss bridge over Little Eagle Creek, Wayne Township; bridge over White Lick Creek in Wayne Township; concrete culvert in Centre Township.

Princeton, Ind.—Until Oct. 9, by County Auditor, for constructing steel bridge.

Rushville, Ind.—Until 2 p. m., Oct. 8, by A. L. Winship, County Auditor, for construction and repair of nine bridges.

Eldorado, Kan.—Until Oct. 8, by W. H. Clark, County Clerk, for the construction of the following bridges and piers: 100-ft. span steel bridge in Little Walnut Township; 100-ft. span steel bridge and a 36-ft. approach in Murdock Township; 76-ft. span steel bridge and a 24-ft. approach in Augusta Township; 24-ft. concrete bridge in Benton Township.

New Ulm, Minn.—Until Oct. 19, by Ernst Wicherski, City Clerk, for the construction of concrete-steel approaches 125 ft. long with roadway to the Middle bridge in the city. Plans and specifications are on file with City Clerk, H. F. Bloomquist, City Engineer.

Burlington, N. C.—Carolina Engineering Co., L. C. Carter, General Manager, Burlington, N. C., has the contract for two highway bridges across the Cape Fear River, one at Lillington and the other at Duke, N. C., and invites bids on the construction of four river piers of 1:3:6 gravel concrete, the total yardage being about 1,100. The bottom is reported as being solid rock, the water is about 6 ft. deep, and gravel and sand as being near by.

Cincinnati, O.—Until noon, Oct. 23, by County Commissioners, Fred Dreihis, Clerk, for following county work: Under Specifications No. 772, for the repair of the floor of the bridge over the Great Miami River at Venice in Colerain Township.

Lisbon, O.—Until Oct. 15, by County Commissioners, for constructing steel deck bridge with concrete floor in Fairfield Township. B. M. French, Salem, O., is County Surveyor.

Mt. Vernon, O.—Until noon, Oct. 12, by C. A. Mitchell, County Auditor, for constructing superstructure of bridge in Wayne Township, superstructure of bridge in Howard Township and substructure of bridge in College Township.

Toledo, O.—Until Oct. 12, by D. T. Davies, County Auditor, for constructing bridge over Swan Creek on Road No. 366 in Adams Township.

Willmington, O.—Until 11 a. m., Oct. 24, by J. M. Fisher, County Auditor, for extending and reinforcing substructure and erecting new superstructure over Little Rattle Snake Creek in Sabina. Bridge is to be of steel, 85 ft. x 20 ft. with concrete floor and 5-ft. walk.

Easton, Pa.—Until 10 a. m., Oct. 9, by County Commissioners, L. A. Francisco, Engineer, for constructing bridge over Bushkill Creek.

Philadelphia, Pa.—Until noon, Oct. 14, by George R. Stearns, Director Public Works, for constructing bridge.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Marletta, Ga.—Until 3 p. m., Nov. 4, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction complete of the U. S. Post Office at Marletta.

Council Bluffs, Ia.—Until Oct. 12, by A. W. Casady, City Clerk, for constructing fire station.

Chicago, Ill.—Until 11 a. m., Nov. 2, by John J. Hanberg, Commissioner Public Works, Room 705, 200 Randolph St., for the general work required in connection with the construction of the new city hall building. Holabird & Roche, Architects, 16th Floor, Monadnock Block. Official advertisement will be found elsewhere in this issue.

Winfield, Kan.—Until 10 a. m., Nov. 5, by

L. E. Shines, Secretary Southwest Kansas Conference College, for the complete erection of a stone, slate roofed, 3-story college building, for the above named college. Malcolm S. Martin, Architect, Hannibal, Mo.

Ann Arbor, Mich.—Until 10 a. m., Oct. 21 (Postponement from Sept. 22) by Board of Regents, S. W. Smith, Secretary, of University of Michigan, for erecting an addition to the Engineering Building. Albert Kahn, Architect, 58 Lafayette Blvd., Detroit, Mich.

St. Paul, Minn.—Until 3 p. m., Nov. 9, by James Knox Taylor, Supervising Architect, Washington, D. C., for the completion of the tower on the U. S. Post Office, Court House and Custom House.

Natchez, Miss.—Until Oct. 12, by Board of Education, B. C. Gilsenberger, for constructing building for Carpenter elementary school.

New York, N. Y.—Until 11 a. m., Oct. 15, by Louis F. Haffen, President Bronx Borough, 177th St. and 3rd Ave., for furnishing labor and materials required for the erection and completion of stable building, wagon house and tunnel for the use of the Bureau of Highways of the Borough of the Bronx, to be erected at north side of East 181st St. Webster Ave. and Park Ave. Security required is \$30,000.

New York, N. Y.—Until 2 p. m., Oct. 16, by Armory Board, Hall of Records, for labor and materials for alterations, improvements, etc., in 69th Regiment Armory. Robinson & Knust, Architects, 164 Fifth Ave., New York.

Mitchell, S. Dak.—Until Oct. 21, by Board of Education, C. W. Dowbey, for erecting high school building.

Dayton, O.—Until noon, Oct. 15, by Board of Education, W. H. Bussard, Clerk, for labor and materials for equipping public schools with fire escapes.

Toledo, O.—Until noon, Oct. 17, by Trustees Toledo State Hospital, Geo. R. Love, Superintendent, for labor and material for erection of a cold storage building (from grade line up).

Toledo, O.—Until 3 p. m., Nov. 10, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction of the U. S. Post Office at Toledo.

Salt Lake City, Utah.—Until 8 p. m., Oct. 9, by Board Public Works, for constructing brick building for suction gas producer plant. L. C. Kelsey, City Engineer.

Fort Monroe, Va.—Until 10 a. m., Oct. 19, by Lieut. David McC. McKell, Q. M., for repairs to building and plumbing of Post Hospital.

Portsmouth, Va.—Until Oct. 15, by H. R. Hamilton, Clerk, 1048 Naval Ave., for erection of 2-story school building and heating apparatus.

Milwaukee, Wis.—Until 10:30 a. m., Oct. 10, by Board Public Works, Charles J. Poetsch, Chairman, for doing the concrete work entering into the construction of a branch public library building on the southeast corner of Madison St. and 5th Ave.

Milwaukee, Wis.—Until 10:30 a. m., Oct. 10, by Board Public Works, C. J. Poetsch, Chairman, for building an office, barn, fence, storage shed, etc., for South Sewerage District.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Oakland, Cal.—Until 10 a. m., Oct. 21, by Board Public Works, Walter B. Fawcett, Secretary, for regrading, paving with asphalt and curbing with granite on Franklin St. Bond for \$1,000 required of successful bidder.

Oakland, Cal.—Until 10 a. m., Oct. 12, by County Supervisors, John P. Cook, Clerk, for grading on Davis St.

Bloomington, Ill.—Until 2 p. m., Oct. 8, by Board Local Improvements, E. H. Packard, Clerk, for constructing vitrified block pavement and combined concrete curb and gutter on part of Washington St.

Chicago, Ill.—Until 11 a. m., Oct. 12, by Department Public Works, Room 705, 200 Randolph St., for paving with macadam Kedzie Ave., from Lawrence to Foster Aves., and Foster Ave. from Kedzie to St. Louis Ave.

Oak Forest, Ill.—Until 1:30 p. m., Oct. 19, by William McLaren, Superintendent Public Service, Cook County, 519 County Court House, Chicago, Ill., for construction of main entrance drive at Oak Forest.

Rockford, Ill.—Until 11 a. m., Oct. 15, by Mark Jardine, President Board Local Improvements, for material and paving, the work including 13,300 sq. yds. concrete foundation, 660 sq. yds. macadam foundation, 3,320 cu. yds. excavation, 25,956 sq. yds. as-

phalt pavement and 2,300 sq. yds. brick pavement. Official advertisement will be found elsewhere in this issue.

Monticello, Ind.—Until Oct. 16, by J. L. Ackerman, County Auditor, for constructing macadamized road in Prairie Township.

Terre Haute, Ind.—Until Oct. 17, by N. G. Wallace, County Auditor, for constructing gravel road in Nevins Township.

Kansas City, Mo.—Until 11 a. m., Oct. 15, by J. L. Darnell, City Engineer, for one contract for constructing asphalt pavement, two contracts for repairing asphalt pavement, eight contracts for constructing artificial stone curbing, one contract for constructing macadam pavement, one contract for constructing concrete pavement and 16 contracts for constructing artificial stone sidewalk.

St. Louis, Mo.—Until Oct. 9, by Board Public Improvements, for paving portions of six streets with bitulithic and one street with brick.

New York, N. Y.—Until 11 a. m., Oct. 15, by Louis F. Haffen, President Bronx Borough, 177th St. and 3rd Ave., for four contracts for repaving with asphalt blocks, two contracts for repaving with granite blocks and one contract for repaving with asphalt or mineral rubber pavement. Largest contract calls for repaving with granite blocks on a concrete foundation a portion of the roadway of Webster Ave., between East 165th St. and East 171st St., and setting curb where necessary, the security required being \$27,000.

New York, N. Y.—Until 3 p. m., Oct. 15, by the Park Board, Arsenal Bldg., 5th Ave. and 64th St., for paving with asphalt tiles certain walks of Central and other parks in the Borough of Manhattan. Security required is \$23,000. Bids are also asked for similar work on ends of parks in Broadway, between 60th and 80th Sts., the security required being \$1,800.

Cleveland, O.—Until 11 a. m., Oct. 21, by County Commissioners, W. F. Black, for improving State Road No. 5, by grading, draining and improving same.

Dayton, O.—Until noon, Oct. 9, by Board Public Service, W. A. Budroe, Clerk, for improvement of Stewart St., by 3,200 lin. ft. of grading sidewalks, setting combined curb and gutter and paving boulder border 2 ft. wide: also 1,600 sq. ft. of cement sidewalk.

Mansfield, O.—Until noon, Oct. 13, by County Commissioners for grading and macadamizing 3.25 miles of road in Springfield Township. Plans, etc., with County Commissioners at Mansfield, and James C. Wonders, State Highway Commissioner, Columbus, O.

Newburgh Heights (P. O., Cleveland), O.—Until 8 p. m., Oct. 20, by P. S. Ruggles, Clerk of Council, for grading and macadamizing with slag from a point 827 southerly from Peck Ave., to a point 3,840 ft. southerly. Ralph Hecker, Village Engineer, 526 Electric Bldg., Cleveland, O.

Youngstown, O.—Until 1:30 p. m., Oct. 17, by Commissioners of Mahoning County, for macadamizing 2,518 ft. of McCuffey St. Edwin D. Hasetline, Engineer, 1818 Wilson Ave.

Beechview, Pa.—Until 7:30 p. m., Oct. 12, by J. H. Zelen, Borough Clerk, for paving with brick. Douglas & McKnight, Engineers, Pittsburg, Pa.

Harrisburg, Pa.—Until noon, Oct. 10, by W. W. Caldwell, Commissioner of Highways, for grading on Sycamore St.

Pittsburg, Pa.—Until noon, Oct. 22, by County Commissioners, for constructing two roads, 1.8 miles and 2.5 miles long. G. T. Barnsley, County Road Engineer, Court House, Pittsburg.

Waynesburg, Pa.—Until Oct. 22, by State Highway Department, Harrisburg, Pa., for constructing following brick and macadam roads in Greene County: Centre Township, 16,293 ft. of road; Franklin Township, Mount Morris road, 21,130 ft.; Oak Forest road, Franklin Township, 3,750 ft.

Wilkesbarre, Pa.—Until Oct. 26, by State Highway Department, Harrisburg, Pa., for constructing 7,183 ft. of state road in Hemlock Township, and 25,534 ft. of state road and one bridge in Plymouth Township.

Guayaquil, Ecuador, S. A.—See under Bids Asked—Sewerage.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Selma, Cal.—Until 7:30 p. m., Nov. 2, by R. C. Gibbs, City Clerk, for constructing sanitary sewer system of vitrified salt glazed sewer pipe. The work will consist of the following: Furnishing, trenching, laying and backfilling 35,345 lin. ft. 6-in. sewer, 10,576 lin. ft. 8-in. sewer, 5,179 lin. ft. 10-in. sewer, 576 lin. ft. 12-in. sewer inside city limits; together with 20,474 lin. ft. of 12-in. outfall

sewer, one sewage tank of 19,800 cu. ft. capacity, all according to plans and specifications on file with the City Engineer, Selma.

Washington, D. C.—Until noon, Oct. 12, by District Commissioners, Room 427, District Bldg., for constructing service sewer.

Louisville, Ky.—Until noon, Oct. 16, by Sewerage Commission, Chas. P. Weaver, Secretary, Equitable Bldg., for construction of Breckenridge St. sewer, Contract No. 13, the work consisting of building a sewer to be constructed of concrete as follows: 1,223 ft. 54-in. diameter; 480 ft. 51-in. diameter; 484 ft. 45-in. diameter. The average depth of cut is 13.4 ft., and approximately 740 cu. yds. of concrete will be required.

Louisville, Ky.—Until noon, Oct. 21, by Sewerage Commission, Chas. P. Weaver, Secretary, Equitable Bldg., for constructing Sec. E, Southern Outfall Sewer, Contract No. 14. The work consists mainly of building a sewer to be constructed of plain and reinforced concrete as follows: 1,965 ft., 12 ft. 3-in. section; 1,510 ft., 12 ft. section; average depth of cut 27 ft.; approximately 5,510 cu. yds. of concrete.

St. Joseph, Mich.—Until 2 p. m., Oct. 14, by Harry L. Murphy, City Clerk, for labor and material for building sewer No. 8 and outlet sewer for southern portion of city.

Springfield, Minn.—Until 8 p. m., Oct. 13, by A. Frederickson, Village Recorder, for constructing 3,091 ft. of 8-in. sewers, 1,590 ft. of 12-in. sewers, with specials, manholes, etc. Certified check for \$300 required with bid. O. Claussen, Consulting Engineer, St. Paul, Minn.

Raleigh, N. C.—Until Oct. 10, by Greater Raleigh Land Co., F. K. Ellington, Vice President, for constructing about 6,000 ft. of 6-in. and 8-in. pipe sewer.

Cleveland, O.—Until noon, Oct. 13, by A. R. Callow, Secretary Board Public Service, for constructing sewer in East 67th St., between Harvard Ave., S. E., and Clement Ave., S. E., with a temporary outlet into Burke brook. Also for furnishing, driving piling and protecting the outlet of the East 40th St. sewer at Kingsbury Run.

Columbus, O.—Until noon, Oct. 14, by Board Public Service, E. W. Hirsch, Secretary, for constructing Michigan Ave. relief sewer, the work including 551 lin. ft. of 42-in. 2-ring brick sewer (alternate bids for concrete construction), 364 lin. ft. 36-in. 2-ring brick sewer (alternate bids for concrete construction) and 200 lin. ft. 15-in. pipe sewer.

Columbus, O.—Until noon, Oct. 9, by Board Public Service, E. W. Hirsch, Secretary, for constructing storm water sewer in Scott St., the work including 1,931 lin. ft. 30-in. sewer, 2-ring brick and 1,043 lin. ft. 24-in. 2-ring brick invert. Alternate bids will be received on reinforced concrete pipe. Henry Maetzel, Chief Engineer, Board Public Service.

Dayton, O.—Until noon, Oct. 9, by Board Public Service, W. A. Burdoo, Clerk, for setting combined cement curb and gutter, grading and paving sidewalks on Irwin St., John St., Broadway, Mutual St. and Baker St.

Sandusky, O.—Until noon, Oct. 10, by Board Public Service, B. J. McGory, Clerk, for constructing lateral sewers in Water, Market, Washington, Jefferson and Madison Sts.

Steubenville, O.—Until noon, Oct. 12, by Board Public Service, H. C. Simpson, Clerk, for constructing sewers in 7th St. and in Linden Ave.

Philadelphia, Pa.—Until noon, Oct. 14, by George R. Stearns, Director Public Works, for constructing branch sewers.

Fond du Lac, Wis.—Until 3 p. m., Oct. 12, by Board Public Works, for constructing sanitary sewer in North Main St.

Parkersburg, W. Va.—Until 8 p. m., Oct. 8, by Board of Affairs, Frank Good, City Auditor, for material and constructing 12-in. and 15-in. sewer, 960 ft. long.

Guayaquil, Ecuador, S. A.—Until Dec. 1, by Sewerage and Water Supply Board of Guayaquil, for sewerage and paving work for the city. Plans, etc., at International Bureau of the American Republics, 2 Jackson Pl., Washington, D. C., with the Legation of Ecuador, at Washington, and with the Consul General of Ecuador, 11 Broadway, New York.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Burlington, Colo.—Until Oct. 12, by Water Works Committee, W. D. Selder, Chairman, for constructing water works, to include 5,647 lin. ft. 4-in. and 6-in. cast iron pipe, pump of 75 gallons capacity per minute,

hydrants, meters, valves, etc., and an elevated steel tank of 60,000 gallons capacity, top of tank to be 100 ft. above foundation.

Oakland, Md.—Until Oct. 19, by J. C. Dunham, Town Clerk, for constructing water works and sewer system. Penniman & Fairley, Engineers, 411 Marine Bank Bldg., Baltimore, Md.

East Grand Forks, Minn.—Until 3 p. m., Oct. 19, by C. P. Zimmerman, for constructing certain portions of water works as follows: (1) furnishing cast iron pipe and special castings; (2) furnishing fire hydrants, gate valves and boxes; (3) pipe laying, (4) pump pit and intake, (5) 100,000 gallon steel tower and tank. Loweth & Wolff, Engineers, St. Paul, Minn.

Helena, Mont.—Until noon, Oct. 29, by J. A. Mattson, City Clerk, for furnishing material and constructing water works system, reservoir pipe line, and distribution system for the city of Helena.

Lower Brule, S. Dak.—Until 2 p. m., Oct. 20, by the Commissioner of Indian Affairs, Washington, D. C., for constructing an artesian well at Lower Brule, Indian Agency, South Dakota.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Fowler, Ind.—Ditch Work—Until 2 p. m., Oct. 10, by C. B. Whicker, County Drainage Commissioner, for constructing ditch and drain.

Vicksburg, Miss.—Levee Work—Until Oct. 14, by Capt. Clarke S. Smith, U. S. Engrs., for about 78,000 cu. yds. of levee work.

Brooklyn, N. Y.—Dredging—Until 11 a. m., Oct. 14, by Bird S. Coler, Borough President, for 1,580 cu. yds. of dredging in Newtown Creek Canal.

Memphis, Tenn.—Levee Work—Until noon, Oct. 10, by St. George Richardson, County Engineer, for building two levees, each requiring about 4,000 cu. yds. of earth.

Peterboro, Ont.—Canal Work—Until 4 p. m., Oct. 20, by L. K. Jones, Secretary Department of Railways and Canals, Ottawa, Ont., for the works connected with the construction of Section No. 7, Ontario-Nice Lake Division of Trent Canal. Plans, etc., at office of Chief Engineer of the Department of Railways and Canals, Ottawa, and at the office of the Superintending Engineer, Trent Canal, Peterboro, Ont.

Port Arthur, Ont.—Dredging—Until 4 p. m., Oct. 9, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for dredging required at Port Arthur.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Chicago, Ill.—Conduit System—Until 11 a. m., Oct. 13, by William Carroll, City Electrician, Room 403, 76 Fifth Ave., for constructing an underground conduit system in South Robey St., for the Department of Electricity, city of Chicago.

Chicago, Ill.—Foundation Work—Until 11 a. m., Oct. 24, by Department Public Works, Room 705, 200 Randolph St., for constructing pump pit, suction well, and foundations for building for pumping station engine house at 164th St. and Stewart Ave.

Chicago, Ill.—Wooden Platform—Until 11 a. m., Oct. 15, by Department Public Works, Room 705, 200 Randolph St., for constructing wooden platform on 15th Pl., between Loomis and Throop Sts.

Marion, Ind.—Electric Light Plant—Until 9:30 a. m., Oct. 13, by Board Public Works, John O. Wilson, Clerk, for constructing addition to electric light plant.

Boston, Mass.—Street Lighting Systems.—Guy C. Emerson, Superintendent of Streets, 47 City Hall, invites parties having street lighting apparatus adapted to systems other than the present system of low-pressure gas mantles to demonstrate, if they so desire, during the continuance of the present contract for street lighting, with a view to the improvement of the present system upon the expiration of the present contract on Sept. 15, 1909.

New York, N. Y.—Electrical Work—Until 2 p. m., Oct. 12, by J. W. Stevenson, Commissioner of Bridges, 13 Park Row, for furnishing and installing the electrical equipment for the overhead trolley system of the Blackwells Island bridge over the East River between the Boroughs of Manhattan and Queens. Security required is \$20,000.

Delaware, O.—Street Lighting—Until noon, Oct. 8, by Board Public Service, R. M. Swickheimer, Clerk, for furnishing and

maintaining electric arc lights on mantle gas lights or both for street illumination purposes for a period of ten years.

National Soldiers Home, Tenn.—Flagstaff.—Until noon, Oct. 25, by Paul E. Divine, Treasurer, Mountain Branch, N. H. D. V. S., National Soldiers Home, for furnishing all labor and material necessary for the complete construction and erection of a 100-ft. iron flagstaff.

Norfolk, Va.—Wharf, Etc.—Until 11 a. m., Oct. 17, by Bureau of Yards and Docks, Navy Department, Washington, D. C., for a timber wharf about 350 by 50 ft., and dredging about 40,000 cu. yds. of mud, etc., at the navy yard, Norfolk.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Cranes.—Until 10:30 a. m., Oct. 17 (postponement of date from Oct. 7), by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing four berm and four chamber cranes under Circular 467.

Chicago, Ill.—Electric Light Wire.—Until 11 a. m., Oct. 13, by William Carroll, City Electrician, Room 403, 76 Fifth Ave., for furnishing the Department of Electricity, city of Chicago, with approximately 200 miles of No. 6, B. & S. gage, triple braid, weatherproof, copper line wire.

Chicago, Ill.—Generators, Pumps, Boilers, Etc.—Until 11 a. m., Nov. 2, by John J. Hanberg, Commissioner of Public Works, Room 705, 200 Randolph St., for the following equipment in connection with the new city hall: (1) generators, (2) switchboard, (3) boilers, breeching and setting, (4) furnaces and grates, (5) pumps, tanks and high pressure piping, (6) hydraulic elevators, (7) electric elevators, (8) engines. Separate bids are asked for each of the above items, official advertisements for which will be found elsewhere in this issue. Plans, etc., with Holabird & Roche, Architects, 16th Floor, Monadnock Block.

East Grand Forks, Minn.—Pipe, Hydrants, Etc.—See under Bids Asked—Water Supply.

Fessenden, N. Dak.—Gasoline Engine.—Until 8 p. m., Oct. 10, by W. E. Macdonald, City Auditor, for a 8-hp. 36-in. stroke, geared gasoline engine.

New York, N. Y.—Broken Stone.—Until 11 a. m., Oct. 15, by Louis F. Haffen, President Bronx Borough, 177th St. and 3rd Ave., for furnishing and delivering 10,000 cu. yds. best quality 1½-in. traprock stone and 5,000 cu. yds. best quality ½-in. traprock screenings.

Columbus, O.—Book Stacks.—Until noon, Oct. 9, by County Commissioners, John Scott, Clerk, for furnishing, erecting and completing eight double, standard steel book stacks in the law library room in the court house.

Scranton, Pa.—Garbage Wagons.—Until 10 a. m., Oct. 8, by C. R. Acker, Director of Public Works, for supplying 10 garbage wagons.

Brownwood, Tex.—Pumping Machinery.—Until Oct. 15, by this city, for furnishing machinery for water works pumping station, including single-acting belt-driven triplex power pump of 1,500,000 gallons capacity daily, and 100-hp. producer-gas engine to operate on Texas lignite coal.

Fort Sam Houston, Tex.—Electric Elevator.—Until 11 a. m., Oct. 25, by L. J. Fleming, Contracting Q. M., for furnishing and installing an electric invalids elevator in new hospital.

CONTRACTS LET.

The following contracts have been let recently:

Fort Smith, Ark.—Sewer Work. Cooney Construction Co., for completing sewer construction work in this city.

Corona, Cal.—Paving.—Highway Construction Co., Redlands, Cal., at \$26,123, for grading, curbing, gutters, sidewalks and paving on Palm Ave.

Los Angeles, Cal.—Paving.—Fairchild-Gillmore-Wilton Co., at \$64,717, for paving Grand Ave., with asphalt; Barber Asphalt Co., at \$23,840, for paving Alameda St., and at \$21,194, for paving Second St.

Oakland, Cal.—Bridge.—Colton Bros. Co., at \$1,948, for erecting steel and concrete bridge over San Lorenzo Creek for county.

Redondo, Cal.—Sewer Outfall.—California Ornamental Brick Co., Los Angeles, Cal., for sewer outfall for this city.

Colorado Springs, Colo.—Sidewalks.—A. Smith for constructing about a mile of sidewalks here.

Laurel, Del.—Electric Light Plant.—W.

Stedding & Sons of Baltimore, Md., for the construction of the new electric light plant here.

Des Moines, Ia.—Sewers.—Dearborn & Jackson, at \$2,677, for constructing lateral sewers.

Des Moines, Ia.—Building.—W. J. McAlpine for erection of new Federal building in this city.

Des Moines, Ia.—Clubhouse.—W. F. Mitchell Co., at about \$30,000 for new Grant clubhouse on High St.

Keokuk, Ia.—School House.—Contracts for new school house to be erected at 9th and Concert Sts., were let as follows: General construction, Griffey & Swan; plumbing, W. P. Sultan; electrical, King Plumbing Co.

Beardstown, Ill.—Bridge Work.—Illinois Steel Bridge Co., at \$1,775 for new 40 ft. bridge on state road near this place; Beardstown Construction Co., at \$960 was awarded contract for concrete substructure work.

Chicago, Ill.—Bridge.—Chicago Bridge & Iron Works, at about \$413,000 for building new S-track bridge at Campbell Ave., for Sanitary District.

Elgin, Ill.—Electric Railway.—The George M. Painter Co., 77 Jackson Blvd., Chicago, according to reports has been awarded the contract to survey and grade the route of the proposed Elgin, Woodstock & Lake Geneva R. R. Work is to be started at once, and it is expected that most of the 90 miles of track for an electric road connecting these towns will be completed by spring.

Mendota, Ill.—Road Work.—Keys & McNamara, at \$3,330 for constructing one mile of road here.

Pekin, Ill.—Bridge Work.—Schmitt Construction Co., Tremont, Ill., at \$1,795 for repairing bridge over Mackinaw River near Boyles' Grove.

Springfield, Ill.—Paving.—Adam Nelch, at \$1.48 per sq. yd., for paving on College St.

Sterling, Ill.—Bridges.—Clinton Bridge & Iron Works, at \$6,000, for erecting seven bridges in Home Township for county.

Streator, Ill.—Grading.—H. L. Hossack, Ottawa, Ill., has contract for grading for interurban line between Grand Ridge and Streator.

Troy, Ill.—Bridge.—Missouri Valley Bridge & Iron Co., at \$1,024 for erecting 48 ft. steel bridge for county.

Marion, Ind.—Sewer.—Dillard Artis at 90 cts. per lin. ft. for constructing sanitary sewer.

Hastings, Mich.—Sewer.—J. H. Algate, Lansing, Mich., for constructing 2,450 ft. of sewer here.

St. Paul, Minn.—Sewers.—P. J. Ryan, at \$1,200 for sewer in Bay St. and at \$1,147 for sewer in Cook St.; D. W. Moore, at \$1,249 for sewer in Lincoln Ave.

Two Harbors, Minn.—Sewer.—Haugsten & Johnson, Two Harbors, at \$5,816, for constructing sewer in 3d Ave.

Meridian, Miss.—Sewer, Bridge.—Rubush, Dabbs & Co., at \$2,600 for constructing sewer in 8th St.; Missouri Valley Bridge & Iron Co., at \$4,747, for constructing 8th St. bridge.

St. Joseph, Mo.—School House.—J. W. Lehr, 1702 Fredrick Ave., for the erection of an 8-room fireproof addition to the McKinley public school in South St. Joseph.

St. Louis, Mo.—Library.—Pierce Bros. Co., New York, for erection of Central public library for city.

St. Louis, Mo.—Paving Work.—Board Public Improvement has awarded following paving contracts: Barber Asphalt Paving Co., 211 North 7th St., Harris Ave., at \$17,902; Rosalie St., \$11,403; Spalding Ave., \$20,737; Parker-Washington Co., 4500 Duncan Ave., Laurel St., \$5,612; Trinidad Asphalt Mfg. Co., paving on McMillan Ave., \$8,059; Ruecknig Construction Co., St. Louis, Michigan Ave., brick, \$5,999; Grand Ave., brick, \$34,733; G. Eyerhmann & Bro., 1216 South Grand Ave., Louisiana Ave., brick, \$45,429; Granite Bituminous Paving Co., paving on Garfield Ave., bitulithic, \$20,299; Schneider Granite Co., paving on Broadway, granite, \$52,606; Webb-Kunz Construction Co., Fullerton Bldg., Columbia Ave., Telford, \$28,408; Heman Construction Co., Fullerton Bldg., Forest Park Blvd., \$37,353.

Missoula, Mont.—Bridge.—William Oliver Bridge Co., Spokane, Wash., at \$128,450, for constructing Higgins Ave. bridge. Bridge will have concrete piers and six steel spans of 200 ft. each and one span of 175 ft., with a 32-ft. roadway and two 10-ft. walks.

Beatrice, Neb.—Bridge.—Standard Bridge Co., Omaha, Neb., at \$3,318, for reconstruction of Holmesville bridge for county.

Long Island City, L. I. (N. Y.).—Concrete Fence.—Turner Construction Co., 11 Broadway, New York, has been awarded a contract by the Long Island R. R. Co. for the construction of 1,800 ft. of reinforced con-

crete fence in connection with their Atlantic Ave. freight yards, Long Island City. Work will be undertaken at once.

Albuquerque, N. Mex.—Railroad Work.—H. E. Culbertson & Co., Cleveland, O., has contract for building extension of New Mexico Central R. R. to the Hagan coal mines.

Greensboro, N. C.—Bridge Work.—W. J. Grantham, Greensboro, for building abutments to a steel bridge across a stream one mile south of High Point; Oswego Bridge Co., Oswego, N. Y., for concrete piers for the McCuiston bridge across Reedy Fork.

Cambridge, O.—Paving.—W. H. Ringwald & Sons, Chillicothe, O., for paving portions of 12 streets for this city.

Hamilton, O.—Pipe.—Lynchburg Pipe & Foundry Co., Lynchburg, Va., at \$17,789, for pipe and specials for city; Jas. B. Clow & Son, Chicago, Ill., at \$2,017, secured contract for pig lead.

Lisbon, O.—Roadwork.—Wm. N. Wright, Lisbon, at \$12,842, for constructing 1.25 miles of state road.

Oklahoma City, Okla.—Sewer.—Bouse & Bouse, at \$1,777, for sewer lateral.

Avoca, Pa.—Church.—Tubbs & Watkins, Taylor, for erection of new Presbyterian church on Main St.

Butler, Pa.—Roadwork.—Tony Morrello, Butler, for constructing state road in Valencia Borough and Adams Township.

Clearfield, Pa.—State Roads.—Gosella & Watts, Dubois, Pa., for state roads in Sandy Township.

Norristown, Pa.—Bridge.—L. F. Shoemaker & Co., Pottstown, Pa., at \$8,775, for steel structure, and Logan Contracting Co., New York, at \$5,530, for substructure for county bridge.

New Castle, Pa.—Storm Sewer.—George

Bros., Washington, for constructing state road in North Strabane Township.

Washington, Pa.—Bridge.—Fort Pitt Bridge Co., Cannonsburg, Pa., at \$6.20 per cu. yd., for masonry, 49 cts. per cu. yd. for grading and \$2,380 for superstructure for bridge to be erected for county in Canton Township.

Tunkhannock, Pa.—Road Work.—Moses Shields Stone Co., Nicholson, Pa., for constructing state road in Factoryville Borough.

York, Pa.—State Road.—E. M. Good Co., Lancaster, Pa., for state road in Warrington Township.

Columbia, S. C.—Bridge.—American Bridge Co., at \$3,300, for steel bridge over canal.

Mitchell, S. Dak.—Power Plant.—Goetz Construction Co., Yankton, S. Dak., for erection of electric light plant for Mitchell Power Co.

Fort Sam Houston, Tex.—Drainage, Water System Extension.—Ling & Hughes, at \$18,566, for construction and drainage system and extension of sewer system at Fort Sam Houston. Trueheart & Jackson, San Antonio, Tex., were awarded contract for extending water distributing system at \$11,273.

San Antonio, Tex.—Theatre.—P. T. Shields for erecting Royal Theatre for H. J. Moore. H. L. Page, Architect.

Austin, Tex.—Pumping Station.—R. V. Dixon, Austin, for constructing new pumping station for city.

Salt Lake City, Utah.—Sidewalks.—Bids were received Sept. 29, by Board Public Works, L. C. Kelsey, City Engineer, for sidewalk extension No. 108, the contract being awarded to James Kennedy Construction Co., at \$203,017. The itemized bids received were as follows: (1) stand for James Kennedy Construction Co., (2) for S. Birch & Sons Construction Co., (3) for J. W. Mellen and (4) for Davis & Heuser:

BIDS RECEIVED SEPT. 29 AT SALT LAKE CITY, UTAH, FOR SIDEWALK WORK.

Abutter's Portion:	(1)	(2)	(3)	(4)
Furnishing and laying vitrified pipe—				
4 in., dia. per lin. ft.....	420	\$0.20	\$0.205	\$0.25
6 in., dia. per lin. ft.....	2,823	.30	.35	.50
8 in., dia. per lin. ft.....	1,534	.43	.45	.60
10 in., dia. per lin. ft.....	129	.60	.63	.70
12 in., dia. per lin. ft.....	1,511	.85	.80	.70
15 in., dia. per lin. ft.....	180	1.10	1.00	.90
18 in., dia. per lin. ft.....	30	2.25	1.50	1.10
24 in., dia. per lin. ft.....	957	2.70	2.35	1.80
Grubbing brush, per acre.....	2.13	30.00	100.00	72.00
Concrete in core walls, per cu. yds.....	14.13	15.00	15.00	25.00
Grading, excavating, per cu. yd.....	39,989.7	.70	.80	.67
Cement pavement, 4 in. thick, per sq. ft.....	938,694.48	.125	.127	.13
Cement pavement, 6 in. thick, per sq. ft.....	12,880.0	.17	.60.00	.17
Furnishing and setting foot bridges, per M ft., B. M.....	33.28	40.00	60.00	60.00
Flumes, per M ft., B. M.....	1.36	37.00	60.00	45.00
Driveway guard timbers, lin. ft.....	6,440	.20	.15	.14
Removing trees—				
6 in. or less dia.....	285	2.00	2.50	2.00
6 in. to 12 in. dia.....	183	4.00	5.00	5.00
12 in. and over dia.....	399	7.00	5.00	7.50
Total abutters' portion.....	\$160,361	\$166,402	\$163,745	\$192,197
City's Portion:				
Grading, excavation, per cu. yd.....	44,222.1	.70	.80	.67
Cement pavement, 4 in. thick, per sq. ft.....	36,617.8	.25	.125	.13
Cement pavement, 6 in. thick, per sq. ft.....	16,327.8	.17	.18	.195
Furnishing and setting flumes, per M ft., B. M.....	68.1	37.00	55.00	45.00
Driveway guard timbers, per lin. ft.....	3,168.9	.20	.15	.14
Removing trees—				
4 in. or less dia.....	5	2.00	2.50	2.00
6 in. to 12 in. dia.....	6	4.00	5.00	5.00
12 in. and over dia.....	23	7.00	5.00	7.50
Total city's portion.....	\$42,656	\$48,021	\$41,587	\$57,338
Grand total.....	\$203,017	\$214,424	\$205,337	\$249,535

Waller, West Pittsburg, at about \$10,000, for constructing storm sewer in South Mill St.

Mercer, Pa.—Road.—South Shore Contracting Co., Erie, Pa., for constructing state road in Findlay Township.

Pittsburg, Pa.—Library.—W. F. Trimble Sons Co., for new Carnegie library at Lang and Hamilton Aves.

Reading, Pa.—Building Work.—A. S. Hoffner, Kutztown, Pa., for erecting two brick wings for Tipton Lutheran Orphans Home.

Scotland, Pa.—Excavation.—C. A. Sims & Co., Philadelphia, Pa., for grade revision work on line of Cumberland Valley R. R. Co. between Scotland and Summit. Work will require 60,000 cu. yds. of excavation, mostly steam shovel.

Uniontown, Pa.—Bridge Work.—County Commissioners have awarded following bridge contracts: Superstructure, Georges Creek bridge, York Bridge Co., York, Pa., at \$1,785; superstructure, Jennings Run bridge, York Bridge Co., \$655; superstructure, Halls Run bridge, Nelson-Meredith Co., \$560.

Washington, Pa.—Road Work.—Reitsch

Seattle, Wash.—Sewers, Paving.—Board Public Works has awarded following contracts: Sewers in Plum and other streets, G. W. Walker, \$15,885; sewers in 25th Ave. South and other streets, C. W. Colt, \$36,666; paving Queen Anne Ave., Barber Asphalt Co., \$19,657; paving East Aloha St., Independent Asphalt Co., \$43,330; grading Pinellas Place, Andrew Paterson & Co., \$48,732.

Seattle, Wash.—Generator, Mooring Buoy.—Bates & Clark, at \$3,670, for generator at garbage plant; Moran Co., at \$41,692, for steel float for mooring buoy.

Spokane, Wash.—Sewer.—J. A. Clark, at \$19,000, for constructing First Ward sewer No. 3.

Tacoma, Wash.—Paving.—N. A. Jones, Tacoma, at \$25,125, for paving on Prospect Hill; Worter Bros., at \$12,455, for paving with sandstone blocks in District No. 406.

Parkersburg, W. Va.—Paving.—L. Heydenreich, at \$2,465, for paving and curbing on 8th St.

Welland, Ont.—Sewers.—J. F. Connolly, Toronto, Ont., at \$51,000, for constructing trunk sewer and four branch sewers for this city.

PROJECTED WORK.

Railroads.

Bridges.

Items Arranged Alphabetically by States.

Porterville, Cal.—City is to at once call for bids for the construction of five concrete bridges across the irrigation ditches of the Pioneer Land Co.

Visalia, Cal.—County Supervisors propose to erect new bridge over King's River near Traver. Seth Smith, County Surveyor, estimates cost of wooden bridge at \$9,000 and cost of steel structure at \$15,000 to \$18,000.

Cambridge, Ill.—County Supervisors have appointed committee to secure estimates on the cost of constructing a bridge over Rock River at Colona.

Evanston, Ill.—City Council Committee is to take up with Trustees Sanitary District of Chicago matter of constructing double deck bridge over Northwestern R. R. tracks at Grant St.

Streator, Ill.—City is considering constructing bridge over Vermillion River at Main St. Council is reported to favor concrete construction, although plans have been received for a steel span to cost \$170,000.

Corunna, Mich.—County Commissioners and Cleveland, Cincinnati, Chicago & St. Louis Ry. have reached agreement regarding construction of a reinforced concrete viaduct at the Glaser St. crossing south of Owosso.

Crookston, Minn.—City has voted to issue \$7,500 of bonds for constructing new steel bridge over Red Lake River.

Gulfport, Miss.—County will vote Oct. 20 on issuance of \$50,000 of bonds for bridge construction.

Fayetteville, N. C.—Council Bridge Committee has rejected all bids for the erection of a steel bridge over Blunt's Creek.

Omaha, Neb.—City Council has instructed the City Attorney to draft an ordinance providing for the erection of a viaduct over 39th Ave., crossing the Burlington tracks.

Celina, O.—County Commissioners have directed Lorie L. Marsh, County Surveyor, to furnish plans and specifications for the following bridges: Harb bridge, 64 ft. span, sub. and superstructure; Sunderman bridge, 75 ft. span, sub. and superstructure; Palmer bridge, repairing superstructure; Hainline bridge, 50 ft. span, sub. and superstructure; Roebuck bridge, 50 ft. span, sub. and superstructure; Solomon bridge, 16 ft. span, sub. and superstructure; Homan bridge, 26 ft. span, superstructure.

Cleveland, O.—City may erect bridge at Jennings Road crossing of the B. & O. and W. & L. E. railroads.

Dayton, O.—Cleveland, Cincinnati, Chicago & St. Louis Ry. will build an \$8,000 reinforced concrete viaduct at the Glaser St. crossing south of the city. O. E. Selby, Cincinnati, O., is Engineer of Bridges, C., C. & St. Louis Ry.

Niles, O.—Board Public Service is taking steps to erect viaduct over the Millrace on Park Ave. extension.

Sandusky, O.—County Commissioners are considering building new bridge over the Huron River at Huron.

Toledo, O.—Board Public Service has recommended that a permanent span be built to replace the temporary piling span of the Cherry St. bridge. The Board has also directed the Wheeling & Lake Erie R. R. to rebuild its bridges over Lagrange and Elm Sts.

Sulphur, Okla.—The Superintendent of Platt National Park is to at once call for bids for two new bridges to be built in the reservation. One of them will be rough stone arch across Sulphur Creek, to cost about \$5,000, and the other will most probably be steel-concrete arch across Rock Creek, to cost approximately \$20,000. H. V. Hinckley, Sulphur, is Engineer.

Butler, Pa.—Viewers have recommended that county construct new bridges in Allegheny and Clinton Townships.

Lewisburg, Pa.—Grand jury has recommended that county construct bridge in West Buffalo Township.

West Chester, Pa.—Viewers have recommended that county construct a bridge over Chester Creek, in Thornbury.

Houston, Tex.—A bond election will be held Oct. 28 to vote \$50,000 for the placing of a bridge across Buffalo bayou.

Milwaukee, Wis.—Committee of the County Board has recommended that bid of James O. Heyworth, 234 Michigan Ave., Chicago, Ill., be accepted for completing the Grand Ave. viaduct. Mr. Heyworth's bid totaled \$345,000.

Items Arranged Alphabetically by States.

Anniston, Ala.—Seaboard Air Line Ry. has asked city for an extension of the franchise granted it about two years ago. At that time the Seaboard Air Line Ry. was granted a right of way into the city by way of Jacksonville, 12 miles to the north. The franchise will expire July 1, 1909, and the company has asked an extension of 18 months, promising to pay the city \$25,000 if the road is not built by that time. W. L. Seddon, Portsmouth, Va., is Chief Engineer Seaboard Air Line Ry.

Magnolia, Ark.—Gulf & Magnolia Northern R. R. Co. has been incorporated and proposes to build a railroad from this city to Hope, a distance of 35 miles. The proposed route is as follows: Beginning at Magnolia, in Columbia County, thence in a northwesterly direction to Waldo, where a junction is formed with the Cotton Belt; thence across the corners of Lafayette and Nevada Counties, into Hempstead County, to Hope, where a junction is formed with the St. Louis, Iron Mountain and Southern. The capital stock is \$1,000,000, and stock to the amount of \$2,000 for each mile of the proposed road has already been subscribed. The board of directors includes J. M. Witt, W. W. Boyd, Henry Strong, R. S. Womack and J. L. Davis, of Magnolia; J. M. Davis, Charles Clark, T. S. Cook, of Waldo; R. M. Brant, A. L. Black, W. Y. Foster, J. R. Betts, S. T. Sears, of Hope, Ark.

Martell, Cal.—The Amador Central R. R. Co. has been incorporated with a capital stock of \$400,000 and will operate the lone & Eastern R. R., which has 13 miles of track and connects lone and Martell. F. J. Solinsky, Jr., San Francisco, Frank W. Wehe, Paul C. Morf, Philip Strubel, Talton Hawes, Joseph L. Scotcher and Fred Hanak are interested.

Sacramento, Cal.—Sacramento Terminal Co. has been formed to construct about eight miles of track in this city. The company is affiliated with the Northern Electric Ry. Co. and will build railways to connect the interurban lines of that company with the waterfront on both sides of the Sacramento River. The capital stock is \$500,000 and the directors include Herbert W. Furlong, Charles W. Harmon, W. G. Hyde, John Leechman and Chauncey S. Goodrich.

San Francisco, Cal.—The California Co. has filed its papers of incorporation and proposes to build a railroad from San Francisco to Sacramento with a line to Petaluma and Napa. The estimated length of the total system is 118 miles and the capital stock is \$2,500,000. Of this over \$1,000 per mile of road has been paid in. The road is to traverse the following counties: Marin, Sonoma, Yolo, Napa, Solano and Sacramento. C. W. Conlisk, R. A. Morton, C. H. Lind, L. W. Pryor, George James, Frank E. Conise and Russell B. Field are directors.

Wellington, Colo.—Surveys for an extension of the Colorado & Southern Ry. from this city to Cheyenne, Wyo., 43 miles, have been completed to Cheyenne. The object of the proposed extension is to connect the Wyoming Division of the C. & S. Ry. with the main system in Colorado. H. W. Cowan, Denver, Colo., is Chief Engineer of C. & S. Ry.

Buena Vista, Ga.—Citizens of this place have subscribed \$50,000 toward securing the construction of a railroad from Buena Vista to Maun, Ga., a distance of 18 miles. Outside capitalists will subscribe \$100,000 for the road. E. B. Hornaday, Buena Vista, is interested.

Terre Haute, Ind.—Cleveland, Cincinnati, Chicago & St. Louis Ry., W. M. Duane, Chief Engineer, Cincinnati, O., is reported to be planning to begin work shortly on double tracking of its line from this city to St. Louis.

New Orleans, La.—Rock Island-Frisco System and Southern Ry. have decided to make extensive improvements to the joint terminals in this city.

Marshall, Mich.—Local press reports quote H. E. Hollar, President of the Columbus, Marshall & Northwestern Ry. as stating that "work on the new road will be begun between now and May 1, next year. The proposition has been under way for over ten years, and its construction is a surety." As projected the line will connect Bay City, Marshall, Lansing, Olivet and other cities, terminating at Mount Eagle, O.

Meridian, Miss.—Surveys are stated to have been completed, right of way secured and necessary capital obtained for the construction of the Mississippi River Western R. R. from Meridian to Natchez, via Mendonville. S. H. Floyd, President Meridian Board of Trade, is interested.

Helena, Mont.—State Board of Land Commissioners have granted Northern Pacific

Ry. right of way for a new line of railroad from Glendive to Mondak in eastern Montana. The granting of this right of way is said to be the preliminary to the construction by that company, of a line north of Mandan, N. Dak., traversing the lower Yellowstone reclamation project, one of the biggest government irrigation schemes. In North Dakota the new line will traverse a section without railroad facilities. The project will involve about 300 miles of railroad building. W. L. Darling, St. Paul, Minn., is Chief Engineer.

Dillon, Mont.—Right of way from Arinstead across the divide to Gilmore, Idaho and nearly to Salmon, Idaho, have been secured for a railroad, now being promoted by W. A. McCutcheon, of Pittsburg, Pa. The primary object of the line is to secure facilities from the Gilmore mines in Idaho, but it is probable that the road will be extended to Boise and on to Butte from Dillon.

Akron, O.—Akron, Canton & Youngstown Ry. Co., K. W. Davis, President, Canton, O., has secured right of way for steam railroad from Akron to Mogadore, eight miles. From the latter place the company intends to extend the road eastward to the Mahoning Valley and to Canton. Plans are being made to begin construction of the first section.

Rapid City, S. Dak.—Rapid City & Wyoming R. R. Co., with headquarters at Rapid City, and a capital of \$50,000, has been incorporated and proposes to purchase or construct a line from Rapid City to Mystic, a distance of 35 miles. The incorporators are H. W. Jones, H. H. Swander, L. A. Richards, J. C. Haines, E. M. Reeves, F. H. Rugg, M. R. Bennett, W. E. Pascal, Thomas Sweeney of Rapid City.

Ione, Wash.—The extension of the Idaho & Washington Northern R. R. to Ione, Wash., will be completed and in operation by November or December, 1909, according to a statement of F. A. Blackwell, Coeur d'Alene, Idaho, President of the road. Surveys are now being made and right of way secured. The projected line from Newport to Ione will be 55 miles long.

Port Angeles, Wash.—Port Angeles Ry. & Terminal Co. has about completed preliminary surveys as far as Port Ludlow, 45 miles from this place.

Oshkosh, Wis.—Wisconsin & Northern R. R., W. Cambric, Chief Engineer, Oshkosh, has let a contract for the extension of the road from Neopit, Wis., to a point about two miles east of Plover, Wis. About 12 miles of road will be built.

Portage, Wis.—J. N. Brann, President and General Manager of the Western Transportation Co. of St. Paul, Minn., is projecting the construction of a railroad from Portage to Friendship and Grand Rapids.

Chihuahua, Mex.—Advices from this place state that work will be commenced as soon as the rainy season is over on the building of the Sierra Madre & Pacific R. R. from Nuevas Casas Grandes, Chihuahua, the present terminus of that railroad from El Paso and C. Juarez on the border, southward to the Chihuahua and Pacific railroad at St. Tomas. H. R. Nickerson, 24 Brand St., New York, is President.

Electric Railways.

Items Arranged Alphabetically by States.

Hanford, Cal.—Stakes have been set for part of route of Fresno, Hanford & Summit Lake R. R. Rights of way have been secured for the route to Fresno and preliminary surveys are under way. The company was recently incorporated with a capital stock of \$1,000,000. L. A. Nares, President of the Laguna Lands Co., Los Angeles, is President; F. S. Granger, Hanford, is General Manager; Joseph D. Biddle, Hanford is Secretary.

Greeley, Colo.—Denver Interurban Construction Co., E. C. Resser, President, has made proposition for building an interurban railway between Denver and Greeley.

Griffin, Ga.—Surveys are underway for an electric railway from Jackson to Griffin. L. W. Roberts, Atlanta, Ga., and W. F. Smith, Flovilla, are interested. About 90 per cent of right of way for the road has been secured.

Davenport, Ia.—Meeting of board of Directors of proposed Davenport & Manchester Interurban railway was held in this city on Oct. 1, to make plans regarding construction work. Fred W. Rank, Moline, Ill., is Secretary of Board of Directors.

Calro, Ill.—Calro & St. Louis Ry. Co. has been chartered with a capital stock of \$100,000, and proposes to construct a line from a point in or near Calro to a point in or near East St. Louis. The incorporators and first board of directors are William B. McKinley, Champaign; L. E. Fisher, Danville; George M. Mattis, Champaign; W. H. Carnahan,

Champaign, and George W. Burton, Champaign.

Decatur, Ill.—Illinois Central Traction Co., Decatur, Ill., is said to contemplate a number of improvements for the coming year, among these being the construction of a belt line around Decatur. Besides the completion of this line it is also the intention of the company to install a new power house at that place for use of the city lines. Among the improvements of the track will be the following: Ballasting of 17 miles of track between Chatham and Girard; new passenger and freight stations at Clinton, Cerro Gordo and Monticello; ballast for lines west and south of Springfield, at a cost of \$50,000.

Springfield, Ill.—City Council has granted Springfield, Clear Lake & Rochester Interurban Co., franchise to operate its cars on several streets in this city.

Evansville, Ind.—Evansville, Princeton & Vincennes Ry. has opened its Patoka extension for service, and the company is now planning the next extension, which will include the bridging of White River. This proposed extension will run north through Knox and Sullivan Counties, connecting with the Terre Haute, Indianapolis & Eastern Traction Co. which will offer through service from Evansville to Indianapolis.

Owensville, Ind.—Surveys of route for Evansville, Mt. Carmel & Olney interurban railway is to be made soon. C. J. Seibert, Evansville, Ind., is interested.

South Bend, Ind.—County Commissioners have granted new franchise to South Bend & Logansport, Ry., by the terms of which work must be started not later than June 1, 1909.

Manhattan, Kan.—City Council has granted a franchise to W. R. West and Joseph T. West, of Kansas City, for an electric railway system to be built in this city. Construction is to begin in 30 days, and one line from depots to the Agricultural college, a distance of two miles, is to be completed within six months.

Lexington, Ky.—Local street railway company is considering extending its lines to the new Knights of Pythias Home, via the Nicholasville Pike and across to Harrodsburg Road.

Lawrence, Kan.—Interurban Construction Co. has had surveys started for its proposed electric railway to Topeka. Dana Templin is Engineer.

New Orleans, La.—The Grand Isle Development & Construction Co. has been chartered here with \$300,000 capital stock, for the purpose of building the proposed electric railroad from New Orleans to Grand Isle, La. The directors are: L. H. Marrero, L. H. Marrero, Jr., J. W. T. Stephens, Seeley Dunn and Chas. Farwell.

Dowagiac, Mich.—Dowagiac Railway Co. organized with \$200,000 capital to build an electric railway from the Indiana state line to Dowagiac, has filed articles of incorporation with the Secretary of State at Lansing, Mich.

Mexico, Mo.—Mexico, Perry & Santa Fe Traction Co. has been reorganized and it is expected will resume construction work on its line between Perry and Mexico. Grading on this section was discontinued the past summer. About 25 miles of right of way has been secured, as well as franchises for building the line in Audrain, Monroe and Ralls Counties. It is also proposed to extend the line to Columbia. Mathias Crum is President, G. W. Galther, Secretary, and S. L. Robinson, General Manager.

Auburn, N. Y.—City has petitioned State Public Service Commission to compel the Auburn & Syracuse and Auburn & Northern R. R. Co.'s to double track their line in the city.

Rochester, N. Y.—State Public Service Commission has authorized the Rochester, Corning & Elmira Ry. Co. to issue the first \$1,000,000 installment of its bonds for constructing its proposed trolley line between this city, Corning and Elmira. The company proposes to begin building the line in sections, starting from the south line of this city. The first section will be from here to Lakeville, on Conesus lake; the second from there to Dansville.

Columbus, O.—Scioto Valley Traction Co., E. R. Sharp, Secretary, Columbus, has increased its capital stock from \$3,000,000 to \$3,500,000.

Defiance, O.—Northwestern Ohio R. R. Co., which projects a line from Defiance to Montpelier, by way of Bryan, may have preliminary surveys made for a line from Rockford, O., to Coldwater, Mich. Mayor Crowe, of Defiance, is President of the Northwestern Ohio R. R. Co.

Astoria, Ore.—City council has granted Oregon Coast Ry. Co., franchise for electric railway through this city. Proposed line is part of projected suburban road from As-

toria via Warrenton and Seaside to Tillamook, for which all surveys have been completed.

Donora, Pa.—Donora-Eldora Street Ry. Co. has let contracts for ties and rails for its proposed electric railway between this city and Eldora.

Spokane, Wash.—Spokane Traction Co. has applied to city council for franchise for extending its lines in the east and south-eastern parts of the city.

Pittsburg, Pa.—Pittsburg & East Liverpool Electric Ry. Co. has been formed to build a railway from Pittsburg to East Liverpool, O., a distance of 35 miles. The officers of the company are: Prof. J. M. Reed, Dravosburg, President; Rev. A. Moore Buchanan, Morgantown, W. Va., Secretary, and J. C. McClaren, of Murdocksville, Treasurer.

Sewers.

Items Arranged Alphabetically by States.

Selma, Ala.—George Vice, Demopolis, Ala., at \$7,455, was low bidder Sept. 22, for constructing trunk sewer for city.

East San Jose (P. O., San Jose), Cal.—H. B. Fischer, Town Engineer, is preparing plans for sewer system for this place.

Sacramento, Cal.—Following bids were received Sept. 19, by County Supervisors, for constructing sewage purification plant for County Hospital Farm: Lattourette & Fical, \$3,900; Felton Lowry, \$4,840; Jenkins & Wells, \$3,737; McGillivray Construction Company, \$4,390; W. B. Bishop, \$3,935; A. Teichert, \$4,210.

San Francisco, Cal.—Marsden Manson, City Engineer, has made plans for new sewer system for the Parkside District requiring about 70,000 ft. of pipe.

San Francisco, Cal.—In order that work may be begun without loss of time for the various sewers proposed on the recently voted bond issue, the Board of Supervisors will pass separate resolutions for each of the units into which the work is to be divided.

East Point, Ga.—City will vote Oct. 28 on issuing \$85,000 of bonds for installing sewer system and water works.

Grundy Center, Ia.—Iowa Engineering Co., Clinton, Ia., has completed plans and specifications for sewer system for this place and city council has decided to call for bids at once.

East St. Louis, Ill.—City Council has passed ordinance providing for a new out-fall sewer to cost \$750,000.

Madison, Ill.—This place and Venice, Ill., are to construct jointly a \$105,000 sewer.

Springfield, Ill.—Board Local Improvements is to construct 18-in. crock sewer in 5th St.

Angola, Ind.—Council has adopted ordinances on construction of complete sewer system and two sewage disposal plants, and will hold public hearing on the matter on Oct. 19.

Clarksville (P. O., Jeffersonville), Ind.—Town Trustees have decided to begin a system of sewer and sidewalk improvements.

Indianapolis, Ind.—Charles A. Brown, assistant City Engineer, has completed specifications for proposed Brightwood sewer, estimated cost of which is \$185,000.

Salina, Kan.—Specifications have been prepared for constructing about 8,000 ft. of lateral sewers for city.

Wichita, Kan.—City Engineer estimates that it will cost the Kansas Sanitarium and Mount Carmel Academy, about \$3,000 to construct a lateral to connect with the new sanitary sewer of city or the West Side.

Franklin, Ky.—City will vote Nov. 3 on issuing \$20,000 of bonds for building sewer system.

Hagerstown, Md.—V. M. Cushman, Hagerstown, has formed syndicate and will ask franchise for installing sewer system here. It is estimated that system could be installed for about \$500,000.

East Lansing (P. O. Lansing), Mich.—Election has been held here to vote on issuing bonds for constructing sewer and water systems.

Mahomet, Minn.—City will vote on bonding for \$7,500 for constructing sewer system.

St. Cloud, Minn.—Council has ordered sewer to be constructed in Third Ward at a cost of \$9,000.

Sea Cliffe, N. Y.—Village Improvement Association will hold meeting Oct. 13, to discuss question of installing sewer system.

Ashtabula, O.—City Engineer has completed plans and estimates for trunk sewers in Sewer District No. 3.

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U. S. Engineer Office, Boston, Mass., Sept. 8, 1908. Sealed proposals for furnishing and delivering electrical junction boxes and cable, will be received here until 12 M., Oct. 8, 1908, and then publicly opened. Information on application. EDW. BURR Lieut.-Col., Engineers.

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ASPHALT AND BRICK PAVING.

Rockford, Ill.

Sealed proposals will be received until eleven o'clock a. m., October 15th, A. D. 1908, at the office of the President of the Board of Local Improvements of the City of Rockford, Illinois, for furnishing material and paving with asphalt and brick certain streets in the City of Rockford, Illinois.

Approximate quantities are as follows:
Concrete foundation, 13,300 sq. yds.
Macadam foundation, 660 sq. yds.
Excavation, 3,320 cu. yds.
Asphalt pavement, 25,956 sq. yds.
Brick pavement, 2,305 sq. yds.

Specifications may be had on application to the City Engineer.

MARK JARDINE,

President of Board of Local Improvements.

PUMPING ENGINE.

Houston, Tex.

Bids will be received up to 3 P. M., Monday, October 19, 1908, for the complete installation of a 15,000,000-gallon pumping engine at the water plant of the City of Houston, Tex.

Further information will be furnished on application to the Water Department, City of Houston, Texas.

H. B. RICE, Mayor.

DRAINAGE WORK.

Oregon, Mo., Sept. 23, 1908.

The undersigned secretary will, until 4 o'clock p. m. of the 10th day of October, 1908, receive sealed bids for the excavation of about 25,000 cu. yds. of earth in the Nodaway Drainage District, No. 1.

Specifications with Chief Engineer or Secretary of District.

WM. M. MORRIS, Secy. of District,

Oregon, Mo.

JOHN PERET, Chief Engineer.

Oregon, Mo.

DRAINAGE WORK LETTING.

Walnut, Illinois.

At the office of M. A. Stiver, Walnut, Ill., on Oct. 9th, 1908, at one o'clock p. m., the Commissioners of Sub-District No. Two of the Union Drainage District No. One, will let to the lowest bidder the job of cleaning out and repairing the Main Ditch of said Sub-District No. Two.

Total work estimate, 25,000 yards.

For plan and specifications write M. A. STIVER, Attorney for District.

JAMES FOLEY,

C. B. KEIGWIN,

A. G. TUCKERMAN,

Commissioners.

PROPOSALS FOR TWO CLAM-Shell Dredge Machines with Boilers. Sealed proposals will be received at the office of the General Purchasing Officer, Isthmian Canal Commission, Washington, D. C., until 10:30 a. m., October 16, 1908, at which time they will be opened in public for furnishing the above-mentioned articles. Blanks and general information relating to this Circular (No. 469) may be obtained from this office or the offices of the Assistant Purchasing Agents, 24 State Street, New York City; Custom-House, New Orleans, La., and 1086 North Point Street, San Francisco, Cal.; also from the U. S. Engineer Offices in the following cities: Seattle, Wash.; Los Angeles, Cal.; Baltimore, Md.; Philadelphia, Pa.; Pittsburg, Pa.; Boston, Mass.; Buffalo, N. Y.; Cleveland, Ohio; Cincinnati, Ohio; Chicago, Ill.; St. Louis, Mo.; Detroit, Mich.; Milwaukee, Wis.; St. Paul, Minn.; Chattanooga, Tenn.; Louisville, Ky.; Mobile, Ala., and Galveston, Tex.; Commercial Club, Kansas City, Mo.; Chamber of Commerce, Quincy, Ill., and Chamber of Commerce and Board of Trade, Tacoma, Wash.—F. C. Boggs, Captain, Corps of Engineer, U. S. A., General Purchasing Officer.

SWITCHBOARD, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday, November 2, 1908, at room 705, No. 200 Randolph street, for the switchboard required in connection with the construction of the new City Hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, Switchboard," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500.00 will be made in room 705, No. 200 Randolph st., to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,

Commissioner of Public Works.

By PAUL REDIESKE,

Deputy Commissioner.

BOILERS, BREECHING AND SETTING, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday, November 2, 1908, at room 705, No. 200 Randolph street, for the boilers, breeching, and setting required in connection with the construction of the new City Hall building to be erected on the west half of lot 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, Boilers, Breeching, and Setting," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of commissioner of public works,

which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500.00 will be made in room 705, No. 200 Randolph st., to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,

Commissioner of Public Works.

By PAUL REDIESKE,

Deputy Commissioner.

FURNACES AND GRATES, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday November 2, 1908, at room 705, No. 200 Randolph street, for the furnace and grates required in connection with the construction of the new City Hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, Furnaces and Grates," and be accompanied with five (5%) per cent of amount of bid in money or certified check, for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500.00 will be made in room 705, No. 200 Randolph st., to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability and that he has the necessary facilities, together with sufficient pecuniary resources to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names as well as the name of the firm, with their address.

JOHN J. HANBERG,

Commissioner of Public Works.

By PAUL REDIESKE,

Deputy Commissioner.



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WATER-WORKS.

East Grand Forks, Minn.

Sealed proposals for the construction of certain portions of a water-works system as hereinafter described, will be received by the City Council of the city of East Grand Forks, Minn., until 3 o'clock p. m., on the 19th day of October, 1908, at which time the said Council will meet and publicly open and read all proposals received.

The work covered by this advertisement will include the following portions or items of a system of water works within and for the said city.

- 1.—The furnishing of cast iron water pipe and special castings.
- 2.—The furnishing of fire hydrants, grate valves and boxes.
- 3.—The pipe laying.
- 4.—The pump pit and intake.
- 5.—A 100,000-gallon steel tower and tank.

All bids must be made on blank forms, furnished for the purpose, and each bid must be accompanied by a duly certified check for a sum equal to five (5) per cent of the amount of the bid, made payable unconditionally to the order of the City Treasurer of East Grand Forks, Minn.

Plans and specifications are on file and blank forms of proposals may be obtained at the office of the City Clerk, and at the office of Loweth & Wolff, Consulting Engineers, St. Paul, Minn.
C. P. ZIMMERMAN, City Clerk.

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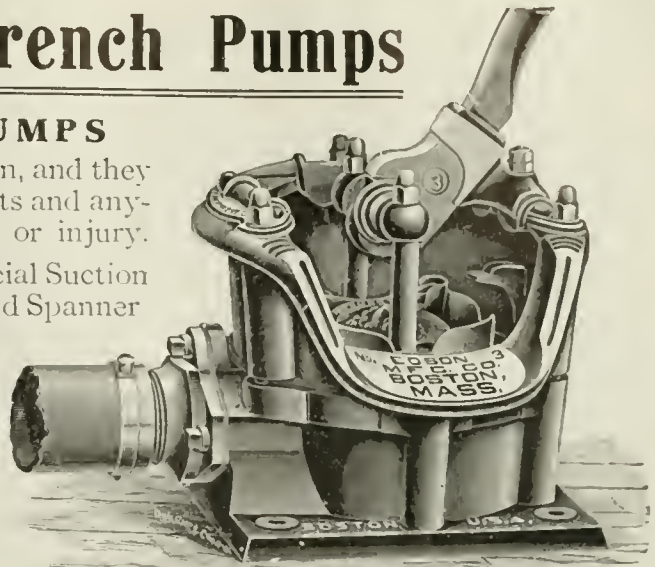
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ENGINES, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday, November 2, 1908, at room 705, No. 200 Randolph street, for the engines required in connection with the construction of the new City Hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office and be addressed to said department, indorsed "Proposals for New City Hall, Engines," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500.00 will be made in room 705, No. 200 Randolph street, to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.

By PAUL REDIESKE,
Deputy Commissioner.

CONCRETE SEWER.

Office of the Commissioners of Sewerage of Louisville, Ky., Incorporated.

Sealed proposals for the construction of a sewer known as Section "E." Southern Outfall Sewer, Contract No. 14, of the Comprehensive System of Sewerage for the City of Louisville, Ky., will be received at the office of the Commissioners of Sewerage until 12 o'clock noon, Oct., 21st, 1908.

The work consists mainly of building a sewer to be constructed of plain and reinforced concrete as follows: 1965 feet, 12 ft. 3 in. section; 1,510 feet, 12 ft. section; average depth of cut 27 feet; approximately 5,510 cubic yards of concrete.

Plans and specifications may be seen at the office of the Commissioners.

Sealed bids should be endorsed "Proposals for Section 'E' Southern Outfall Sewer," and addressed to the Commissioners of Sewerage, Equitable Building, Louisville, Ky. Each bid must be accompanied by a certified check for at least seven per cent (7%) of the total amount of the bid or a "Bidder's Bond" as described in the form of proposal.

P. L. ATHERTON,

Chairman.

CHAS. P. WEAVER, Secy. and Treas.

J. B. F. BREED, Chief Engineer.

MACADAMIZING ROADS.

State Highway Department,
Columbus, Ohio, Sept. 30, 1908.

Sealed proposals will be received at the office of the Commissioners of Richmond County, Ohio, until 12 o'clock, noon, October 13, 1908, for grading and macadamizing 3.26 miles of road in Springfield township, said county, under the provisions of the state highway law.

Specifications, plans and profiles are on file in the office of the County Commissioners in Mansfield, Ohio, and at the State Highway Department.

Copies of specifications may be obtained at the latter office.

Estimated cost of construction \$19,307.10.

Certified check \$300.00.

The State Highway Commissioner reserves the right to reject any and all bids.

JAMES C. WONDERS,
State Highway Commissioner.

GENERATORS, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday, November 2, 1908, at room 705, No. 200 Randolph street, for the generators required in connection with the construction of the new City Hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, Generators," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500.00 will be made in room 705, No. 200 Randolph st., to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities together with sufficient pecuniary resources to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.
By PAUL J. REDIESKE,
Deputy Commissioner.

PUMPS, TANKS AND HIGH PRESSURE PIPING, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday, November 2, 1908, at room 705, No. 200 Randolph street, for the pumps, tanks and high-pressure piping required in connection with the construction of the new City Hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, Pumps, Tanks and High-Pressure Piping," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city and giving such bond as may be required for the satisfactory performance of the same within five days from its date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500.00 will be made in room 705, No. 200 Randolph street, to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.
By PAUL REDIESKE,
Deputy Commissioner.

GENERAL WORK, CITY HALL, DEPARTMENT OF PUBLIC WORKS.

Chicago Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday, November 2, 1908, at room 705, No. 200 Randolph street, for the general work required in connection with the construction of the new city hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, General Work," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid

is rejected, and if the bidder is successful, upon bidder entering into contract with said city of Chicago and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500 will be made in room 705, No. 200 Randolph street, to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.
By PAUL REDIESKE,
Deputy Commissioner.

HYDRAULIC ELEVATORS, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday, November 2, 1908, at room 705, No. 200 Randolph street, for the hydraulic elevators required in connection with the construction of the new City Hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, Hydraulic Elevators," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500.00 will be made in room 705, No. 200 Randolph street, to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.
By PAUL REDIESKE,
Deputy Commissioner.

ELECTRIC ELEVATORS, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday, November 2, 1908, at room 705, No. 200 Randolph street, for the electric elevators required in connection with the construction of the new City Hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office and be addressed to said department, indorsed "Proposals for New City Hall, Electric Elevators," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city and giving such bond as may be required for the satisfactory performance of the same within five days from date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500.00 will be made in room 705, No. 200 Randolph street, to insure the safe return of plans and specifications.

No proposals will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.
By PAUL REDIESKE,
Deputy Commissioner.

WATER EXTENSIONS.

Kings Park, N. Y.

Sealed proposals endorsed "Proposals for Extension of Water Supply System at Kings Park State Hospital, Kings Park, N. Y.," will be received by the State Commission in Lunacy, Capitol, Albany, N. Y., up to 3 o'clock p. m. on the 14th day of October, 1908, when they will be opened and read publicly.

Proposals shall be accompanied by a certified check in the sum of \$700.00 and the contractor to whom the award is made will be required to furnish Surety Company bond in the sum of \$7,000.00. The right is reserved to reject any or all bids.

Drawings and specifications may be consulted and blank forms of proposal obtained at the Kings Park State Hospital, Kings Park, N. Y., or at the office of the State Architect. Complete sets of plans and specifications will be furnished to prospective bidders upon reasonable notice to, and in the discretion of, the State Architect, Franklin B. Ware, Albany, N. Y.

T. E. McGARR, Secretary,
State Commission in Lunacy.
Dated Albany, N. Y., Sept. 22, 1908.

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for Civil Engineers and Contractors.

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Conduit Manholes.

Several of our contemporaries have published during the past month a description, with photographs, of a manhole for conduit work used by Mr. W. Thomas Wooley, City Engineer of Auburn, N. Y., stating that the idea of the design was either entirely new or unique. This shows clearly how engineers frequently do not keep abreast with engineering literature.

The conduit manhole in question is one containing both high and low tension wires, and to prevent crossing them, the manhole, instead of being built barrel shape, is built in two semi-circular sections, one slightly in advance of the other, so as to prevent this crossing of wires. Such a manhole was illustrated in this journal April 1, 1908. In "Telephone Construction, Methods and Cost," by C. Mayer, page 269, such a manhole is illustrated and described as follows:

"On many of the important lines of conduit where it is possible for the operation of workmen in the streets to result in damage to the manholes, it has been the practice to construct the manholes of standard form, not of larger proportionate width, building one-half of the manhole a distance in advance of the other half along the line of conduit, so that lateral connections may be made from either half of the manhole either way without the necessity of crossing cables. The diagram of such a manhole is shown in the figure."

The diagram shows a manhole similar to Mr. Wooley's design, and the manholes described have been designed and used by Mr. Chas. E. Phelps, chief engineer of the Electrical Commission for the city of Baltimore, Md., for a number of years.

There is but one difference between Mr. Wooley's design and that of Mr. Phelps. The latter has left out the wall between the two sections, as this not only saves money in construction, but allows the use of only one manhole plate, and access from one section of the manhole to the other. The manhole can be built amply strong without this wall.

A Suit to Prevent the City of Los Angeles From Doing Day Labor Work.

In our issue of Sept. 23, we mentioned the fact that the city of Los Angeles, Cal., had rejected the bids made by contractors for work on the construction of the aqueduct from the Owens River, and had commenced the building of this \$23,000,000 project by day labor. We sounded a warning that to do such work by day labor means, as a rule, both increased cost and a poor quality of work.

This work is being done under the supervision of the Board of Public Works of the city, the board consisting of General A. R. Chaffee, A. A. Hubbard and D. K. Edwards. The chief engineer is Mr. William Mulholland, and Mr. J. B. Lippincott is

his first assistant. Against this board, and also the city auditor and treasurer, a taxpayer's suit has been brought in the Superior Court of the County of Los Angeles, asking that the Board of Public Works be enjoined from carrying on this work by day labor, and that the city auditor be enjoined from approving bills and pay-rolls for day labor work, and that the city treasurer be enjoined from paying such demands.

The taxpayer who has brought this suit is Col. Edwin R. Fox. Col. Fox, is president of the Utah Oil & Mining Co., and is said to be an engineer and contractor of wide and varied experience, and a specialist in construction work of this character. In his complaint to the court, Col. Fox, who had no interest whatever in any of the bids made for the aqueduct work, says:

"Each one of these bids (of the contractors—Editors) was accompanied by a certified check, or a sufficient bond of 5 per cent of the estimated sum total of the amount bid, conditioned that if awarded the contract, he would, within ten days, enter into a contract to perform the work, and furnishing as a guarantee, a bond in the sum of \$500,000, that he would complete the contract, and a further bond to pay labor and material, to the amount of 50 per cent of the aggregate amount of his bid, a bond ranging from \$1,500,000 to \$2,000,000.

"At the time of handing in the said estimate and comparison of the bids, the Chief Engineer also handed in an estimate of what he calculated he could do the work for the amount named being \$1,956,578. This last estimate did not have, accompanying it, any guarantee of responsibility for the correctness of their calculations.

"Thereupon the Board of Public Works decided by resolution to reject any and all bids, and perform the work by day labor.

"The plaintiff has carefully examined and analyzed the estimate subsequently submitted by the Chief Engineer, and finds an abundance of absurdities and inconsistencies in it, and prices named for certain parts at which it would be utterly impossible to perform the work, and in different sections, a difference of almost 50 per cent in the cost of identical work, in almost identical conditions. Taking the estimate of the Chief Engineer as a whole it would be impossible for the most careful contractor to complete at that price.

"The plaintiff believes that, while it is possible that some of the bids presented were unreasonably high, and that some of the bidders had not the experience warranting the award, it is only a reasonable presumption that a re-advertisement would have brought before the board a reasonable price from someone incontestably competent to carry out the work.

"The plaintiff alleges that it is a fair presumption, based on all past experience, that a municipality cannot execute a large piece of work within any reasonable cost, in

comparison with that of a contractor, and that the municipality generally receives bids at a much less sum than it can do the work for itself, unless there is a combine among the contractors; which in this case was impossible, as they came from such widely separated sections.

"That the city cannot complete a piece of work at a price in comparison with a contractor, is evidenced in the recent case of the outfall sewer, where this plaintiff made a proposition which would have completed the sewer for \$125,000, with a possible expenditure of \$25,000 more for incidentals not provided for under the city's day labor account the sewer was completed, according to the returns of the City Auditor, for \$670,711.94—an addition of over \$220,000, or 50 per cent of the contracts offered.

"The law provides that all public work shall be let by competitive bidding, Sec. 148 City Charter; except in the case of emergencies when the amount does not exceed \$500. That it can hardly be assumed that an emergency will arise that involves over \$2,000,000 urgent expenditure, or that it shall be so urgent that it requires the city to perform it by day labor."

Col. Fox has set forth a number of excellent reasons why this important work should be done by contract. It is a singular thing that many engineers do not readvertise for bids when the first bids they receive are not satisfactory, but, instead, turn to the expensive day labor method. It is also singular that engineers so often imagine that their own estimates of cost are infallible standards by which to judge the reasonableness of bidding prices. Elsewhere in this issue will be found a list of the bids received for the construction of that portion of the aqueduct referred to in the suit.

The Great Steel Plant at Gary, Ind.

We give an unusual amount of space in this issue to a general description of the great new steel plant at Gary, Ind. The publication of general descriptive articles has purposely been so rare heretofore in the columns of ENGINEERING-CONTRACTING that some explanation of the present variation from usual practice seems called for. The new steel plant at Gary is not only very large, but is being built absolutely new with ample room and ample capital available; it embodies, therefore, what, in the eyes of its engineers, is considered the most perfect modern practice in steel works engineering. The engineer and the contractor who reads the article understandingly gets, therefore, not merely the details of a specific plant, but he gets also a knowledge of what the highest developments in steel works engineering are.

But the steel works at Gary are of interest to everyone for other than technical reasons, and these reasons have been so well expressed recently by one of the company's officials that we present them in his words:

"The undertaking at Gary by the United States Steel Corporation was the result of its recognition of the necessity to do something on a large scale in the West to take care of the rapidly growing demand for steel and iron products. To give you an idea as to the rapidity with which the demand for these products has grown, I will state that in the year 1890 the total production of steel in the United States was 4,000,000 tons; in the year 1895 that production had grown to 6,000,000 tons; in the year 1900 it had grown to 10,000,000 tons; in the year 1906 the United States produced 23,000,000 tons of steel products.

"Our plans for enlargement were first had with respect to the existing plants of the Illinois Steel Company, the principal plant being at South Chicago. Chicago possesses many of the essentials of manufacture on a large scale; but we soon saw that there was not sufficient elbow room at South Chicago for bringing forth or perfecting our large plans for the building of an additional steel plant. Hence we began to cast our eyes around for a suitable place for the location of large steel mills. Our observations were confined to the shore of Lake Michigan; we could not afford to break ourselves away from the transportation afforded by the lake for our ore supplies. Attention was called to the sand dunes in the northern part of Lake county, and the site attracted us. Investigation of the depth of the water immediately in front of this land convinced us that there was possible a most magnificent harbor for our shipping; a sufficient depth of water could be had to float the ships of the largest draught. We also found good railroad facilities in this vicinity; better, in some respects, than at Chicago, especially with reference to terminal and transfer facilities. Therefore we cast our lot in the northern part of Indiana.

"After deciding to build the steel plant at this site, amid this waste and these sand dunes, we recognized at once the necessity of the Steel Corporation's undertaking to build a place for the homes of its employees. Therefore we were forced to undertake the commencement, at least, of a town. Our connection with the town of Gary was a necessity; no one else would undertake the expenditure of the capital necessary to make the homes for our employees. Amid this waste and these sand dunes it was not to be supposed that anyone would have sufficient confidence in the mere announcement of the plan of the corporation to build a big steel plant that would employ eventually 15,000 men; capital cannot be persuaded to invest in homes on a mere statement of that kind. Therefore the Corporation had to acquire sufficient land not only for its steel plants but for the starting of a town.

"The first subdivision of Gary comprises about 800 acres of land, which has been laid off into something over 4,000 lots. The purpose of the Corporation with respect to this comparatively small area is merely to

give a sample, or endeavor to give a sample, of the lines along which Gary should be built. We were anxious to avoid the conditions which are usually incident to a new community.

"We purpose in this first subdivision to complete it with well-paved streets and with a sewerage system that has been designed by the best of engineers so as to secure the best possible sanitation for the community. It will be equipped with a water works that will give Gary a supply of water inferior to none on the lakes. The capacity of the water plant being constructed can be extended almost to an unlimited degree. It involves the construction of a tunnel over 15,000 ft. in length, 7,000 ft. of the tunnel being beneath the waters of Lake Michigan, and going out to a depth that will insure as pure water as can be obtained from that source.

"The gas works will have a capacity from the start to serve a population of over 25,000 people. All of these public utilities are being provided by a subsidiary company of the United States Steel Corporation under franchises obtained in the regular way from the Town Trustees. In seeking these franchises we represented that they could be safely intrusted to us and that the Corporation did not seek them merely for the profits which may be made out of them. They will be administered in the best interests of the community, because by so doing the Corporation will be best administering its own interests. We are to depend for our profits upon the steel business. We know more about the steel business than we do about running a town. We shall gladly welcome the day when all the affairs of Gary can be taken over by an organization, in due course of law, with no attempted direction by the Corporation."

In Saxony, where much damage has been caused to the forests, by the ravages of caterpillars, an especial contrivance has been arranged for the destruction of the moths. This consists of three powerful searchlights placed close to exhaust pipes on the roof of the local electric light works. In one night 130 lbs., estimated at half a million moths, were taken by this contrivance.

The steam shovels owned by the Isthmian Canal Commission are as follows:

45-ton Bucyrus	10
70-ton Bucyrus	35
95-ton Bucyrus	32
Model 20, Marion	1
Model 60, Marion	7
Model 91, Marion	16
Total	101

The annual report of the Botanical and Forestry Department of China for 1907 shows that a total of 57,905 trees have been planted in Hongkong during the year, while 178,361 sites have been sown with pine seeds during the same period.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Cost of Concrete Lining of Tunnel for South Canal, Belle Fourche Irrigation Project.

The following figures are given in the "Reclamation Record" as the cost of lining a tunnel 1,306 ft. long and 8 x 8 ft. in clear section with 1-2½-5 concrete. The actual quantity of concrete placed in the lining of the tunnel was 1,595 cu. yds., whereas the number of cubic yards of concrete for which payment would have been allowed under the requirements of the specifications is 1,712. Owing to the efficiency and accuracy of the excavation work the quantity of lining required was reduced by the difference of these two quantities. The sand and gravel for use in the concrete were obtained at one end of the tunnel from natural beds and the concrete was mixed at this point. The tunnel is located 18 miles from the nearest railroad station. Labor was plentiful throughout the execution of the work and the average rate of wages paid per 8-hour day was \$2.30. The unit costs given in the table below are based on the pay quantity of 1,712 cu. yds. In order to determine therefore the cost per cubic yard of concrete placed based on the actual number of cubic yards the cost given should be increased by about 8 per cent. The cost given in the table is exclusive of charges for survey and designs.

Distribution of cost.	Total cost.	Cost per cu. yd.
Preparatory expense	\$ 731.30	\$0.43
Plant depreciation	725.73	0.42
Superintendence	318.00	0.18
Camp maintenance	430.03	0.25
Cement	4,544.11	2.65
Lumber and steel forms...	861.08	0.50
Miscellaneous materials ..	45.20	0.03
Fuel	105.14	0.06
Lighting	81.43	0.05
Miscellaneous supplies	230.80	0.14
Repairs .....	.....	.....
Hauling cement	1,624.25	0.95
Hauling gravel and sand..	432.32	0.25
Crushing and screening gravel and sand	205.17	0.12
Mixing and placing concrete	1,565.71	0.92
Hauling forms	106.95	0.06
Labor on forms and runways	890.61	0.52
Blacksmith	137.19	0.08
Finishing	373.02	0.22
Miscellaneous labor	611.74	0.36
Administration	878.25	0.51
Engineering	633.07	0.37
Inspection .....	.....	.....
Total cost to U. S.	\$15,531.10	\$9.07

According to statistics just published, the number of miles of railway in Brazil in actual operation on Jan. 1, 1908, was 10,915; the number of miles under actual construction was 2,053, while plans have been approved for the construction of 4,142 miles more.

Reinforced Concrete Stone Bins and Trestle for the Street Department of Springfield, Mass.

The city of Springfield, Mass., repairs its streets, which are paved largely with macadam, with its own forces and materials. In following out this policy it has to purchase and handle a large quantity of crushed stone. To facilitate storing this material and loading it to teams the Street Department, Mr. A. A. Adams, Superintendent, decided to construct a combined trestle and stone bins which would enable the broken stone to be dumped directly from the railroad cars into bins and by means of gates in the bottom of the latter be transferred to teams which could drive under the trestle. The accompanying illustrations give an excellent idea of the result-

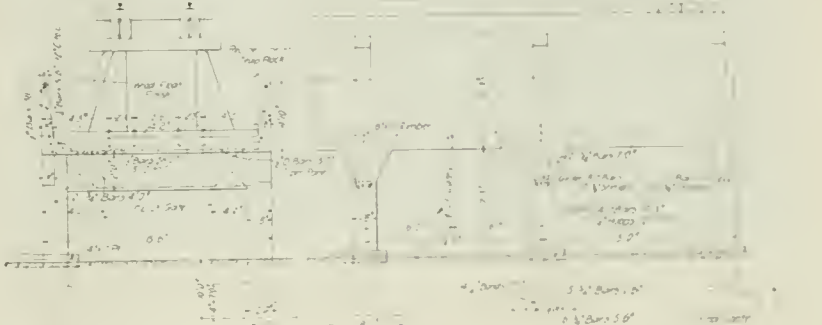


Fig. 1—Cross-Section and Side Elevation of Stone Bins.

ing structure. Figure 1 shows a cross-section and side elevation; Fig. 2 gives details of the bottom gates, and Fig. 3 shows the wheel-guard construction at the base of the columns. The Boston & Albany Railroad has a connection with this trestle and runs bottom dump ballast cars out on the wooden trestle which is built on top of the concrete bins. The total length of this concrete structure is 182 ft.; the width is uniformly 15 ft. 6 ins. The details of the reinforced concrete work are clearly shown by the drawings. The wooden trestle which supports the railroad track rests on concrete bents consisting of two columns 20 ins. square connected with a girder 3 ft. deep and 14 ins. wide with a clear span of 12 ft. 2 ins. Connecting each bent and forming the floor of the stone bins is a 12-in. reinforced concrete slab. Extending above the top of this slab to a height of 4 ft. are two light retaining walls.

The reinforcement used in this work consists of cold twisted bars. The girders

connecting the concrete columns are reinforced with six 1-in. bars and twelve ¾-in. stirrups. The columns have four 1-in. bars landed together at 12 in. intervals with ¼-in. hoops. In addition, in the tops of the

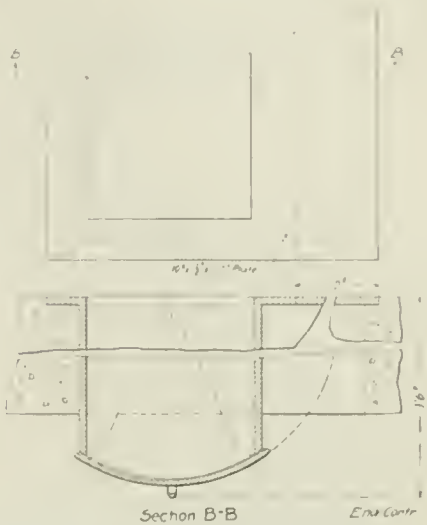


Fig. 2—Details of Bottom Gates.

columns are four ¾-in. bars running at an angle with the vertical axis of the column of approximately 30° and reinforcing the knee braces.

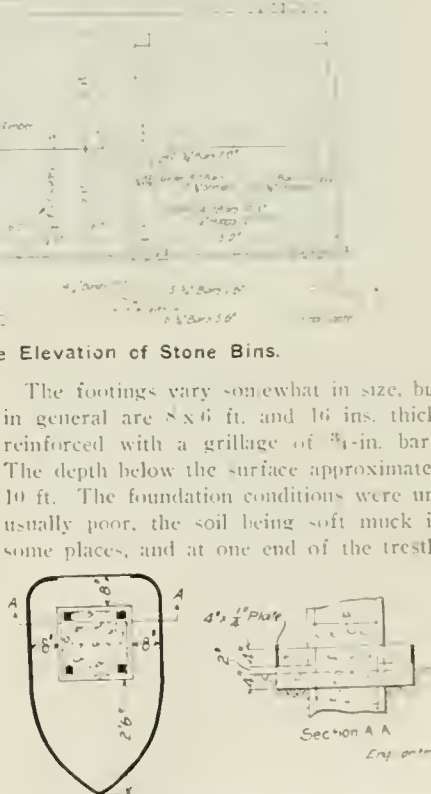


Fig. 3—Wheel-Guard Construction for Base of Columns.

an old sewer had to be crossed. This was taken care of by a girder footing spanning the sewer. Extreme care was necessary with the soft sub-soil conditions to procure a reliable footing for the concrete piers. The work was not delayed, however, to amount to much and the trestle has been in

use now about six months without any defects showing.

The method of construction employed was similar to that used on most reinforced concrete jobs. The columns were filled first, then the beams and floor slab cast together, and the retaining wall put on afterwards. This is well shown by Fig. 1. The work can be followed in this illustration through all its stages. The column reinforcement shows in the foreground, the column and beam forms in place with the men laying steel, and further to the right a recently concreted slab. At the extreme right several sections of the retaining wall have been completed and the forms for them are still in place. The method of bonding the columns into the rest of the structure, which goes to take care of the moving loads to which the structure is subjected, is indicated by the reinforcement sticking up into the retaining wall.

For the form work $\frac{7}{8}$ -in. T. & G. North



Fig. 4—View Showing Method of Construction.

Carolina roofing was used for all panels. The column forms and girder bottom and sides were made out of 2-in. spruce dressed both sides. The column brackets and all supports under the slabs and girders were of 4 x 4-in. spruce. For spreaders and incidental bracing 2 x 6-in. and 2 x 8-in. spruce was used. Bolting with $\frac{3}{4}$ -in. bolts was resorted to wherever possible on the wall forms and column brackets.

This entire structure was completed in four weeks after the first excavation was undertaken. The forms were removed two weeks after concreting and the trestle was put in place within about a month. The first locomotive was run over the trestle five months after the concrete work was finished. The maximum capacity of the stone bins is about 570 cu. yds. or approximately 20 carloads. The total cost of the work to the city of Springfield was in the neighborhood of \$8,000. The structure was designed and built by the Turner Construction Co., of New York city.

The production of crushed stone in the United States in 1907 was 35,028,121 tons.

LETTERS TO THE EDITORS.

The Commercial Value of Fine Grinding of Portland Cement.

Sirs—I have just read Mr. Richard K. Meade's article in your issue of Sept. 30th on "The Commercial Value of Fine Grinding of Portland Cement," and take the liberty of submitting a few data bearing on this subject and relating particularly to the points raised by Mr. Meade. The experimental work on which the results given are based was carried on in the laboratory of the Engineering Experiment Station of the Iowa State College. A report of these tests has recently been published in Volume X of the Transactions of the American Ceramic Society.

In the series of tests referred to a standard brand of cement was used, portions of the market article being reground in a ball mill. One sample was ground continuously

do show plainly the increase in the amount of excessively fine flour as the period was increased. Regarding the excessively fine as the hydraulically active part, it appears, therefore, that the regrinding has not only reduced the upper limit of size of particle but has also brought an increasing proportion of the intermediate sizes to a degree of subdivision where they become active cement.

As to soundness, the accompanying Table III shows no decided change or tendency in the finer ground cements to the development of important defects.

The influence of fine grinding on the time of setting is indicated in Table IV.

The decrease in the time required for both initial and final set with increasing fineness is decided and rapid.

Table V is a summary of the tensile tests of the reground cements. Each figure given is the average breaking strength of ten briquettes.

These data do not in all particulars point to the conclusions of Mr. Meade, particularly, "That the neat strength is *lowered* by finer grinding." The results of my tests show that fine grinding gives added strength at the end of *shorter periods of time*. It will be noted that the 24 hour tensile strengths increase persistently with the increased fineness, and this improvement seems sufficiently large as to be unmistakable. At the end of seven days, however, the difference in strength, while appreciable, is not sufficiently decided for one to say whether the tendency is an increase or merely an allowable variation. The 28-day results indicate an appreciable diminishing in strength, but here again the tendency is not so strong as to warrant the conclusion that fine grinding produces this effect. The results of the neat cement tests as a whole suggest the conclusion that fine grinding promotes *rapid* hardening, therefore, a relatively high strength in a short time, but that the increase after the first few days is slower than the gain in strength of the coarser cements.

Mr. Meade's second conclusion, "That the sand strength is increased by finer grinding" is supported by the figures given

TABLE I.—FINENESS TESTS OF REGROUND CEMENT.

	Retained on 100 mesh.	Passing 100 re- tained on 200 mesh.	Passing 200 mesh.
Market	3.45	20.80	75.75
After 2 hours grinding.....	0.27	11.19	88.54
After 5 hours grinding.....	0.15	8.75	91.10
After 9 hours grinding.....	0.02	3.20	96.78
After 14 hours grinding.....	0.00	1.22	98.78

Portions of the cement passing the 200-mesh sieve were further separated into a series of sizes by the settling process, using dry kerosene as the liquid. Settling periods of 30 seconds, of 1 minute, and of 5 minutes were used. The figures given in the table are percentages, the totals in this compilation being the amounts passing the 200 mesh shown in the table.

While in a way these figures give an idea only of the efficiency of the ball-mill, they

in the table, and the trend of the results seems so decided as to be unquestionable.

The working qualities of the different cements differ more and more widely from those of the market article as the fineness increases. The finer products became sticky to the trowel and to the hands, and this, along with the increasing rapidity of the initial set, rendered the finest grained samples annoyingly difficult to handle.

A number of interesting questions arise

in connection with this subject. Mr. Meade suggests a variation in the chemical composition of the fine cement flour and the coarser particles as accounting for, first, the fact that some portions of the clinker are ground finer than others in the mill, and, second, the quick set of the pulverized ce-

serving only as so much exceedingly fine sand. If this is true, the coarser, non-hydraulic, part acts as a retarder when the cement is used, but would, if finely ground, possess hydraulicity. It is as yet unknown just where the boundary lies, in size of particle, between active and inactive ce-

ly small proportion of active material. The practical question that might come to the cement manufacturer who must place upon the market a usable product, is that of pulverizing the entire kiln output to such a fineness that it will all become hydraulically active, and then add from some cheaper source inert ingredients to regulate the working and setting properties.

What the ultimate effect of fine grinding of cement in use will be is as yet unknown. While it hardens more rapidly no one is ready to say that it actually possesses a greater bonding power, or that it will or will not attain an ultimately greater strength. Rapid hardening would render possible the early removal of forms in concrete construction, while a cement of higher ultimate strength would be used in less quantity or with a larger proportion of aggregate, the former possibility reducing the massiveness of the structure, both highly desirable objects of attainment. But with rapid hardening appears to be quick setting and any user of cement knows well the difficulties of teaching his workmen to handle a material which departs in any important or essential property or working quality from what he is accustomed to. The solution of the practical questions that arise in this connection would be apt to mean either a revolutionizing of present methods of using cement, an improbability, or bring about such alteration of the chemical composition or physical nature of present Portland cements as to retain, or, reproduce, their present working qualities.

The investigations thus far carried on along this line have, it is freely confessed by the writer, served only to open up an abundance of interesting questions, and to emphasize the at present narrow limits of our real knowledge of this important building material.

Yours very truly,

IRA A. WILLIAMS,

Associate Professor Mining Engineering,
Iowa State College.

Ames, Ia., Oct. 4, 1908.

During the year ending May 31, 1908, the Street Cleaning Department of Glasgow, Scotland, handled 353,175 long tons of refuse of all kinds, an average of nearly 1,129 tons per working day. Of this, 94,157 tons were sold to farmers as city manure and 22,259 tons as stable manure. This year's expenditure was \$696,677 and the revenue amounted to \$181,657, derived as follows: Manure, \$158,296; tins, light iron, and galvanized iron, \$9,636; clinker, \$8,320; waste paper, \$3,007; heavy scrap iron, collected from workshops, \$2,112; sundries, \$286. The special service for the collection of waste paper, according to a recent Consular Report, is a marked success, in view of the fact that it has to cope with private enterprise. Food unfit for consumption, comprising fruit, vegetables, beef, tinned meats, fish, and eggs, were destroyed to the amount of over 83 tons.

TABLE II.—FINENESS TESTS OF REGROUND CEMENT PASSING 200-MESH SIEVE.

	Settling from suspension 30 secs.	1 min.	In kerosene in 5 mins.	In suspension in kerosene after 5 mins.	Total.
Market	25.43	12.08	9.71	28.53	75.75%
2-hour	27.39	17.12	13.77	29.96	88.54%
5-hour	31.50	16.28	18.17	35.15	91.10%
9-hour	25.93	15.54	17.63	37.68	96.78%
14-hour	19.91	17.21	16.56	45.10	98.78%

ment. It occurs to the writer that we have little reason to expect any considerable variation in chemical composition and therefore in actual hardness between large and smaller particles of clinker. Is it not more probable that the fragments of clinker vary as they come from the kiln, due to the nature of the burning process rather

ment. Dr. Michaelis, Jr.,* suggests that only particles of 800-mesh size are cement proper, that is to say, only these almost infinitesimally small particles are capable of combining with water under the conditions of common use. No doubt different brands of cement would run different in this particular.

TABLE III.—SOUNDNESS—NEAT CEMENT.

Sample	Normal.	Accelerated.
Market	O. K. in air and water.	No defect, put loose from glass.
2-hour	O. K. in air and water.	O. K.
5-hour	In air, small shrinkage and expansion cracks.	O. K.
9-hour	In water O. K.	O. K.
14-hour	In water O. K.	O. K.

than to a lack of homogeneity in the raw mix and a consequent variation in composition? Then the fact that there are coarser and finer particles in the pulverized clinker, cement, could be due alone to the longer time required to reduce large than

It would seem possible, therefore, to pulverize the entire clinker to such fineness that every particle would become active. In such case all data at hand point to the probability of a cement with much different properties than is possessed by the present day market products. It would set more quickly and the above results indicate a more rapid hardening or gain in strength. Evidence of a stronger chemical activity in setting is seen not only in the rapidity of the set but also in the increasing percentages of water required as the fineness of grain becomes greater. The products obtained in the settling analysis of the portion passing the 200-mesh sieve were studied with the results in Table VI.

TABLE IV.—SHOWING EFFECT OF FINENESS ON

	TIME OF SETTING.	
Sample.	Initial set in minutes.	Final set in minutes.
Market	45	180
2-hour	40	150
5-hour	30	135
9-hour	17	65
14-hour	5	17

to reduce small particles to a fine state of subdivision. Under this assumption the difference in the properties of coarse and finely ground cements would depend on physical variation in the cement rather than chemical.

It is well known that only a portion of

TABLE V.—SUMMARY OF TENSILE TESTS
REGROUND CEMENT.

Sample.	Neat cement, lbs. per sq. in. at the end of	1 cement, 3 sand lbs. per sq. in. at the end of
	24 hours.	24 hours.
Market	135.9	555.3
2 hours	327.9	532.3
5 hours	348.8	568.3
9 hours	291.6	522.9
14 hours	365.0	596.7

ordinary Portland cement is sufficiently fine to possess setting power when given water. Some have set the proportion as low as 40 per cent of the commercial article, the remaining 60 per cent being too coarse and

On the assumption again of a uniform chemical composition for the clinker, the inference from the above figure is that fineness of grain is the all important factor. In other words, grind the entire cement to excessive fineness and an entirely unusable product would result. But it seems a most expensive and circuitous course to follow to obtain that 50 or 60 per cent of the ordinary Portland cement which so far as we know acts as a diluent only in the relative-

*Journal Western Society of Engineers, Vol. XIII, No. 1, p. 455.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Excavating Gravel in a Canal with a 65 Ton Shovel.

We are indebted to Mr. J. B. Brophy, of Trenton, Ontario, Canada, division engineer of the Trent Canal, Department of Railways and Canals, for the following data as to the working of a steam shovel under him for the month of June, 1908.

The work was done at the canal near Trenton, Ontario. The material was a gravel. The cutting was 10½ feet deep and was side cutting, the material being loaded into cars as high as the machine would reach. From June 1 to 13 the shovel excavated 16,000 cu. yds., the average haul being 1,200 ft. From June 15 to 30, 20,000 cu. yds. were excavated, the average haul being 1,100 ft. This makes a total of 36,-

standard wages on this class of work, which are:

Shovel runner	\$125 per mo.
Craneman	90 per mo.
Fireman	60 per mo.
Watchman	40 per mo.
Dinkey runners	\$3.00 per day
Brakemen	2.00 per day
Foremen	3.00 per day
Oiler	1.75 per day
Laborers	1.50 per day
Water boy	1.00 per day
Teams	5.00 per day

During the month 26 days were worked. The total cost of the work and the organization of the forces were:

Loading:	
1 Shovel runner	\$125.00
1 Craneman	90.00



70-Ton Shovel Working in Clay.

000 cu. yds. with an average haul of a little more than 1,300 ft.

The outfit used on the work consisted of the following: A 65 ton steam shovel with a 2½ cu. yd. dipper, made by the Bucyrus Steam Shovel Co., of South Milwaukee, Wis. Two 12-ton Porter dinkeys. About ¼-mile of track was used and 22 dump cars of 1 cu. yd. capacity. The cost of this outfit was approximately as follows:

65-ton shovel	\$9,000
2 12 ton dinkeys	5,000
22 4-yd. dump cars at \$230.....	5,060
16 tons 20-lb. rails at \$32.....	512
1,000 ties at 10 cts.....	100

Total

1 Fireman	60.00
1 Pitmen	156.00
1 Team hauling water	180.00
50 tons coal at \$5.00.....	250.00
Oil, waste, etc.	10.00

Total

Hauling:	
2-Dinkey runners	\$156.00
2 Brakemen	104.00
1 Oiler	15.50
1 Trackman	39.00
60 tons coal at \$5.00.....	300.00
Oil, waste, etc.	16.00

Total

Dumping:	
1 Foreman	\$ 78.00
16 Laborers	624.00
1 Water boy	26.00

Total

Miscellaneous:	
1 Superintendent	\$150.00

1 Timekeeper	65.00
1 Watchman	40.00
Track gang:	
1 Foreman	78.00
5 Laborers	195.00
Interest, depreciation and repairs (estimated)	390.00

Total

Grand total

The cost per cu. yd. of material excavated was:

Superintendence	\$0.007
Loading	0.024
Hauling	0.018
Dumping	0.020
Track work	0.008
Int., deprec., and repairs (estimated)	0.010

Total

The yardage moved in one shift is very large for this size shovel. For another output of a 65-ton Bucyrus shovel see ENGINEERING-CONTRACTING, Aug. 5, 1908, page 82. On the Trent canal 1,385 cu. yds. were moved in a 12-hr. shift, which would be at the rate of 1,155 cu. yds. in 10 hrs., or 115 cu. yds. per hour. When it is remembered that only 4-yd. cars were being loaded and the bank was only 10½ ft. high, this record is a very good one. It means that the shovel was actually digging earth about one-half of its time. These are the reasons for the very low costs.

The contractors on this work are Larkin & Sangster, of St. Catharines, Ontario. Mr. J. H. Wallace is superintendent in charge of the work.

Some Records of Drilling and the Cost of Maintaining Drills.

In driving two tunnels on the Tieton project, of the U. S. Reclamation Service, near North Yakima, Washington, wood drills, manufactured by the Wood Drill Works, of Paterson, N. J., were used.

Compressed air was used to operate the drills, one drill working in each heading. The North Fork tunnel was 3,811 ft. long and of 7 ft. 3 ins. in diameter. The material through which the tunnel was excavated was a broken basaltic rock, about one-third of the material being very blocky basalt with clay seams, inclining to over-break beyond the neat section of the tunnel. The tunnel should have run a little more than 1½ cu. yds. per lin. ft., while it actually ran in excess of 2 cu. yds. In all, 8,601 cu. yds. of material were excavated. Work was begun in the tunnel July 20, 1907, and the two headings met Aug. 13, 1908, the time consumed being 13 months. This meant a monthly progress from the two headings of 293 ft. One drill was used in each heading.

The Tieton tunnel was 2,929 ft. long and 7 ft. 3 ins. in diameter. About two-thirds of the material was very hard basaltic rock, breaking well, the rest being basaltic boulders and clay. The number of cu. yds. excavated from this tunnel was

4,774, being about 1.7 cu. yds. per lineal ft. The drills were installed on Aug. 4, 1907, and the two headings met May 20, 1908, the time being 9½ months, making a monthly progress in the two headings of 287 lin. ft.

The number of drill shifts worked in the North Fork tunnel, of 8 hrs. each, was 1,330, while in the Tieton tunnel 932 drill shifts were worked. The drills sunk about 65,400 lin. ft. of holes, making an average of 29 lin. ft. of hole per 8 hr. drill shift.

There were 10 lin. ft. of drill holes drilled for each lineal foot of tunnel, and 5 lin. ft. of hole drilled for each cubic yard of excavation. The drills used were all of 3 in. size.

The cost of maintaining the four drills for this work and period of time was as follows:

Labor	\$372.78
Material	915.60

Total

It must be remembered that the wages paid in this section of the country are high, while the work was a long distance from the base of supplies, thus adding to the cost of materials.

The average cost of maintaining one drill was as follows:

Labor	\$ 93.19
Material	228.90

Total

The cost of maintaining the drills per lineal foot of tunnel, per lineal foot of hole and per cubic yard of excavation was as follows: Per Lin Ft. Per Lin. Ft. Per Cu.Yd.

Repairs.	Tunnel.	Hole.	Excavation.
Labor	\$0.057	\$0.006	\$0.028
Material ...	0.040	0.014	0.068
Total ...	\$0.197	\$0.020	\$0.096

The cost of drill repairs was therefore 58 cts. per drill per 8-hr. shift.

Although labor conditions were generally good on this job, yet some trouble was experienced in obtaining competent drill runners, with the result that inexperienced men were used at times, which was naturally harder on the drills. At the end of the job the drills were in good condition.

Consideration must also be given to the character of the excavated materials. The rock was very hard, yet seamy, and some of it was blocky, all causing extra wear on the drills. Yet the maintenance costs under the conditions worked are very low, the repair work being done in the field and not in a well rigged shop, and there being but four drills to maintain. A comparison of the above costs per lineal foot of hole drilled, per cubic yard of rock excavation or per month of work, with costs of drill repairing given in the Gillette's "Rock Excavation, Methods and Cost," show that they are quite low.

We are indebted for the above information to Mr. Chas. H. Swigert, project engineer of the Reclamation Service, in charge of the Tieton project.

Method and Cost of Moving Earth and Loose Rock in Small Cars.

We are indebted for the following information, as to the cost of excavating materials with small cars, to Mr. A. William Sperry, engineer and contractor of New Haven, Conn., the work having been done under Mr. Sperry's direction.

The cars used on the work were all steel dump cars, manufactured by the Arthur Koppel Co., of Pittsburg and New York. Six to nine cars were used, of 36 cu. ft. capacity, running on a 24-in. gage track. These cars weigh 900 lbs., and stand 4 ft. 2 ins. above the top of rail. They cost about \$80 apiece. The rail used was of 20 lb. section, costing about \$30 per ton.

The excavation was made from a borrow pit alongside a railroad track, with the result that no ties were needed for the dirt track, but the rails were laid directly on the old ties and between the rails of the standard gage track. This is an economical method when lighter rails are used than those in the standard gage track, but, when the same weight rail is used in both tracks, then it is necessary to lay only one rail for the dirt track, using one rail of the standard gage track for the dirt cars. This effects a considerable saving in money in track. In all 2,000 lin. ft. of track were used.

There were 7,000 cu. yds. of material taken from the lower pit, and hauled an average of 1,000 ft., down grade, about one-half being a 2% grade and the other half a 4% grade. In making the fill, at times the rail was laid on grades as high as 8 or 10%. The cars would readily coast from the lower pit, and were drawn back by horses.

The material was a glacial deposit, containing from 15 to 20% of large boulders, fully 50% of which had to be blasted. The cost of blasting is included in the record of cost given below. These boulders prevented the material from being classed as earth. Under most specifications for excavation, the material would have been classed as earth and loose rock.

The cars were taken to the dump in trains, a brakeman being used on each train. Three to four horses working single, with a driver, hauled the cars back to the cut. One man was also used on the dump, and he also attended to the track work.

A 10-hr. day was worked and the following wages were paid:

Laborers	\$1.10 to \$1.65
Brakemen	1.75
Dumpman	1.75
Firemen	3.00
Drillers	1.65
Single horse and driver.....	3.00

From 35 to 45 laborers were used on the work, from 3 to 6 drillers and 2 firemen. The firemen attended to the blasting. It was necessary to build a temporary trestle across a highway at a cost of \$195.

The following is the cost per cubic yard

for each item of the work compiled from the total cost:

Loading cars	\$0.215
Temporary trestle across highway ..	0.015
Drillers	0.035
Explosives	0.010
Dumpmen and track work	0.023
Horses and drivers	0.015
Brakemen	0.022
Freight and hauling on outfit	0.025
Depreciation of plant (about 7½%) ..	0.015
Superintendence	0.015

Total

Owing to the large number of boulders in this work, scrapers could not have been used in excavating the material. The boulders, too, were very hard on the cars; nevertheless the cars stood up well under the work. Owing to the down grade, the cars were much more economical in doing this work than either dump carts or wagons would have been.

The track work cost about \$80 for this job, thus making an average cost of 4 cts. per lin. ft. of track laid and taken up; but it must be remembered that no ties had to be laid.

It will be noticed that the cost of blasting was 4½ cts. per cu. yd. excavated, more than 75 per cent of the cost being for the drilling. As there were only about 700 cu. yds. of boulders blasted, the cost per cubic yard for blasting for the boulders actually blasted was 15 cts. The hauling of the material cost nearly 7 cts. per cu. yd.

Taking into consideration the class of material excavated and the cost of blasting and the temporary trestle, the cost for the work is very reasonable.

Of the many experimental roads undertaken by the United States Office of Public Roads, perhaps the most out of ordinary is near Newton, Mass. Here a half-mile stretch of road has been leveled for a molasses road. This molasses is the almost useless by-product of the great cane sugar refineries of the south and the beet sugar refineries of the west and south-west. It is sickishly sweet, nearly as black and as thick as tar, and is said to be almost as powerful a binder. Having always been a waste product, it can be bought at a lower price than coal tar and in greater quantities. In laboratory experiments it behaved so well and held out such promises for ideal roads that the practical test of a real road was decided upon. At Chicago, Ill., the Office of Public Roads is experimenting with a road constructed of blast furnace slag combined with asphalt. At Independence, Kan., an expert from the Office of Public Roads has been engaged in experiments trying to devise a method of constructing oiled roads analogous to the methods which have produced the famous oiled roads of southern California. He is mixing heavy oils, possessing pronounced asphaltic bases, with natural soil and sand and compacting the preparation so formed with a tamping roller.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Dust Preventives: Tars, With Methods of Analysis and Suggested Specifications for Their Use.

The suppression of dust on roads is a problem which has become prominent within recent years, and its importance is rapidly increasing. Many and varied experiments have been made with dust preventives and the results obtained have to some extent been contradictory, even when the experiments have been carried on in the same manner and under the same conditions. As a result much confusion has arisen in the minds of road engineers as to the value of the different preventives. In order to supply specific information on this subject the U. S. Office of Public Roads has recently issued a bulletin prepared by Mr. Prevost Hubbard, Assistant Chemist in the Office, and the matter in this article has been taken from that bulletin. In this article only artificial bitumens (tars) are considered. The essential requisite for any dust preventive is its binding power, or, in other words, its power of holding together the fine material produced on the surface of the road. With some few exceptions, all of the true binders are bitumens and these bitumens may be either natural or artificial.

Crude tars, as well as specially prepared tars and tar emulsions have been used extensively for dust prevention. As a class, tars are liquid bodies obtained from the destructive distillation of such organic substances as wood, bone and coal. The latter is by far the most important source of tar at present, and coal tar has been the material most extensively used as a dust preventive. The principal kinds of coal tar used for dust preventives are crude coal tar, refined coal tar and water gas tar.

Crude Coal Tar.—Crude coal tar is mostly obtained in the manufacture of illuminating gas. The true tarry products are known as artificial bitumens in contradistinction to the natural bitumens found in various mineral oils and asphalts. The nature of the tar varies with the nature of the coal from which it is derived, and also with the conditions under which it is produced. In its qualities as a road builder, by far the most important factor will be found in the temperature at which the tar is produced. As the value of coal tar as a dust preventive lies mainly in the binding power of the heavier bitumens contained in it, it is evident that an excess of free carbon which has no binding value at all will prove detrimental. The same may be said of such substances as naphthalene and anthracene, and as these materials are produced in increasing amounts as the tem-

perature is raised, it follows that the best results must be obtained by the use of tars produced at a low temperature. When it is considered that the actual bitumens present in a tar may vary from 60 to 95 per cent and the carbon from 5 to 35 per cent according to the temperatures employed in the retorts, the importance of ascertaining the chemical properties of the crude tar, or at least its method of manufacture, before purchasing it for use as a dust preventive is evident.

Refined Coal Tar.—Much of the tar now produced is subjected to fractional distillation for the separation of certain constituents which are used in the arts. The residue left in the still is known as coal-tar pitch, and is a thick, viscous material while hot. It represents the true binding base of the tar, and if the tar is one produced at a comparatively low temperature, the residue is composed mainly of bitumens. After

light oils; and, if not too costly, a preparation of this kind is to be preferred to the crude tar. The absence of water makes it easier to handle when applied hot, and probably allows of a better absorption of the tar by the road surface. If much water is present in a tar the road material is apt to absorb it before the tar, and the road thus becomes, to a certain extent, tar-proof. As a result the tar is very likely to peel. Water in the tar itself will also hasten disintegration of the heavy binding materials. The ammoniacal liquor may saponify some of the oily products which are then rendered capable of mixing with water and therefore are apt to be washed out. Dehydrated tar may be readily prepared by boiling the crude material in open kettles until its boiling point lies between 105° and 110° C. Great care must be taken, however, to prevent the tar from boiling over, as it has a strong tendency to foam while the water is being driven off.

Comparatively few experiments have been made with water-gas tar as a dust preventive, but from the few made it seems safe to say that the results obtained will not be as lasting as from the use of coal tars. It does compare quite favorably, however, with some of the lighter oils and oil and tar emulsions. The approximate com-

TABLE I. SPECIFIC GRAVITY AND COMPOSITION OF TAR PRODUCTS.

Kind of tar.	Specific gravity	Ammoniacal water. Pct.	Total light oils to 170° C.		Total dead oils, 170°-270° C.		Residue (by difference.) Pct.
			Pct.	Pct.	Pct.	Pct.	
Water-gas tar.....	1.041	2.4	a21.6	b52.0	c24.0	d24.0	e24.0
Crude coal tar.....	1.210	2.0	d17.2	e26.0	f54.8	g54.8	f54.8
Refined coal tar.....	1.177	0.0	b12.8	d47.6	f39.6	g39.6	g39.6

a Distillate mostly liquid; b Distillate all liquid; c Pitch very brittle; d Distillate mostly liquid and brittle; e Distillate one-half solid; f Pitch hard and brittle; g Distillate one-third solid.

cooling for a few hours it is run out of the still and is graded as soft, medium, or hard, according to its condition when cold. The dead oils, which represent the heavier distillation products, and which are of less value than any of the other volatile distillates, are often run back into the still before the pitch is drawn off. In this case the pitch is liquid when cold.

In preparing a tar for use as a dust preventive most of the valuable products are removed by fractionation, and the least valuable products—that is, some of the carbolic and all of the dead oils—are run back into the pitch until about the same consistency is reached as that possessed by a heavy crude tar. Sometimes the addition of the dead oils from previous distillations is required to bring the mixture to this consistency. These oils give life to the tar, and, provided the percentage of pitch is not reduced too low, a mixture of this sort evidently has certain advantages over the crude tar, as it is comparatively free from naphthalene and anthracene and contains none of the light volatile oils and ammoniacal liquor found in the latter.

Dehydrated Tar.—Sometimes only dehydrated crude tar is prepared for dust prevention, the idea being to remove all water, ammonium compounds, and some of the

position in percentage volumes as determined by fair representatives of the three principal kinds of tar used as dust preventives is given in Table I. The notes to the table refer to the condition of distillates and residues when cold.

METHODS OF EXAMINATION AND TENTATIVE SPECIFICATIONS.

It is always well when selecting a dust preventive to make as complete an examination of the material as possible. As this often necessitates a chemical analysis, however, which is sometimes difficult to make, a few easy tests have been selected which will give a fair indication of the dust-laying and the road-building properties of the material under examination. Most of the methods described may be used by any person with the aid of a few simple appliances which will be described under the different tests; the more difficult analyses have been omitted. There are, at present, no standard methods for the examination of dust preventives. In rare instances experimenters have made attempts to ascertain the properties of the materials which they have had occasion to employ and in some cases have formulated specifications for their own use, but in general this branch of the work has been neglected. Considerable research is

required before entirely satisfactory methods of examination and specifications can be decided upon, and it should be understood that the following are offered as a guide only. Investigations are now being conducted along these lines both in the laboratory and in the field, and it is the intention of the Office of Public Roads as soon as possible to present the subject in greater detail.

EXAMINATION OF TARS.

Specific Gravity.—The most convenient method of determining the specific gravity is by means of a thin spindle hydrometer. These hydrometers, graduated in direct specific gravity readings, may be obtained from any dealer in chemical apparatus at small cost, either singly or in sets. One ranging from 1.000 to 1.200 is most suitable for water-gas tar and crude coal tar. The refined tars, however, and those to which pitch has been added, may run somewhat above 1.200. When the tar is too viscous to allow the hydrometer to settle properly it is either necessary to dilute it with a known proportion of some lighter material, such as coal tar benzol, or else to weigh a known volume of the material.

If the former method is employed it is of course necessary to predetermine the specific gravity of the benzol used. As an example, we may take a very viscous coal tar and mix it thoroughly with an equal volume of coal tar benzol of say 0.880 specific gravity. The hydrometer might then show the specific gravity of the mixture to be 1.050. By multiplying this value by 2 and subtracting the specific gravity of the benzol we should obtain a fairly accurate determination of the specific gravity of the original tar as follows: $(1.050 \times 2) - 0.880 = 1.220$. Unless the hydrometer is graduated to read at a different temperature all specific gravity determinations should be made at ordinary temperature; that is, about 68° F. or 20° C.

By weighing a known volume of the tar and dividing this weight by that of an equal volume of water its specific gravity may also be determined.

While in itself the specific gravity determination is of little service in determining the actual properties of the tar, it indicates certain facts which, taken in connection with other tests, often prove of considerable value. In general the higher the specific gravity the more pitch will be present, but free carbon is also apt to be found in greater quantity. While coal tar varies from 1.10 to 1.20, it is seldom that one is found under 1.12. If the specific gravity is lower than this the presence of lighter products, such as water-gas tar or oil-gas tar, may be suspected. A refined tar should have a specific gravity of at least 1.18, or otherwise it is apt to be deficient in pitch. Owing to the presence of a greater proportion of heavy oils, a refined tar may contain less pitch than a crude product, even though its specific gravity is higher.

Boiling Test.—The boiling test may be made by heating a quantity of the tar in an open vessel and by the use of a thermometer, noting the point at which it boils and also whether or not it shows a tendency to foam.

A determination of the boiling point is of value in distinguishing between a crude and a refined product. Crude tars invariably contain water, which causes them to foam when heated to their boiling points, which may run from 190° or lower to about 212° F. Dehydrated tars, or those from which the water only has been removed, will not foam, but their boiling point will be but little over 212° F. They can therefore be distinguished from the truly refined tars, which usually have a higher boiling point, owing to the removal of the second light and carbolic oils.

Distillation or Fractionation Test.—The fractional distillation of coal tar requires special apparatus and a certain amount of skill, which can be acquired by experience only in order to obtain satisfactory results. A detailed description will be found in the work by Allen. In general it is carried on in much the same manner as the refining of coal tar, which has been described (see page 12). The operation is, of course, conducted on a miniature scale.

By this means the approximate composition of the tar is determined and the proportion of the various fractions ascertained. When examining a specially prepared or refined tar in this manner, a general idea may also be obtained as to how the preparation has been made and what effect has been produced upon the character of the binding base. Unless this test is conducted with great care, however, the results are apt to be misleading.

Test For Coal-Tar Pitch.—The hardness of coal-tar pitch may be roughly determined in the following manner: Soft pitch softens at about 104° F. and melts at about 140° F. It can be easily kneaded between the teeth. Moderately hard pitch softens at about 110° F., melts at about 176° F., and can be kneaded with difficulty between the teeth. Hard pitch softens at about 176° F., melts at about 248° F., and crushes to powder.

In preparing a tar for road-construction purposes it is often desirable to reinforce its binding qualities by the addition of pitch. A soft pitch is the most suitable for this purpose, as it is more readily dissolved by the tar and contains a greater proportion of heavy life-giving oils than the harder pitches.

Determination of Free Carbon.—The determination of free carbon in coal tar and coal-tar pitch can not be carried on well outside of a chemical laboratory. No entirely satisfactory method has yet been devised, but a close approximation can be made by digesting from 2 to 5 grams of the material over night with about 150 c.c. of coal-tar benzol. By this means all of

the soluble bitumens are diluted to such an extent that they may be filtered from the insoluble carbon which remains in suspension. The solution is decanted upon a weighed Gooch crucible, the bottom of which is covered with an asbestos felt. By means of a vacuum it is filtered into a suction flask, the residue washed into the crucible with coal tar benzol, and the washing continued until the filtrate runs clear. The crucible is then heated until all the benzol is driven off, and after cooling is weighed. The additional weight represents the free carbon, which should be calculated upon a percentage basis. Free carbon may also be determined by means of a Soxhlet extractor.

The presence of an excessive amount of free carbon in coal tar and coal-tar pitch is detrimental to the binding power of the material. Owing to a lack of data it is impossible at the present time to decide just how much carbon should be allowed. It is always present to some extent in both the tar and the pitch, no matter how carefully they may have been prepared. When high temperatures have been employed in their production, however, the carbon content will be excessive, and for this reason mainly the use of high-temperature products should be avoided. The determination of free carbon is most important and should be made when possible and the percentage noted in a statement of the results obtained from the use of any particular tar. By this means a better idea may be formed as to how much carbon may be present without seriously affecting the results. Other things being equal, it is safe to say that the best results will be secured from the use of that product containing the least free carbon.

Determination of Naphthalene, Anthracene, Etc.—No very accurate method of determining these substances on a small scale has been devised. Some idea may be obtained of the relative quantities present in any two materials by comparing the amount of solids found in the distillates produced by fractionation. Refined tars, as a rule, have had a portion of these substances removed, and in this respect are to be preferred to the crude products.

SUGGESTIONS FOR SPECIFICATIONS FOR THE QUALITY OF COAL TARS TO BE USED AS DUST PREVENTIVES OR ROAD PRESERVATIVES.

Tar and tar preparations may be used in any one of four ways: as temporary binders, semipermanent liners, permanent binders applied to the surface of a road, or as permanent binders in road construction. It is evident, therefore, that different specifications should be made according to the different uses.

1. When used as a temporary liner it is usually employed in the form of an emulsion, and at present it is impossible to frame any satisfactory specification, owing to the fact that many of these emul-

sions contain other binding materials besides tar.

11. When used as a semipermanent binder it is necessary that sufficient binding base be present to last throughout a dusty season, and, for reasons of economy, that the material be sufficiently fluid to apply cold. For this purpose the following specifications may be tentatively made:

1. The coal tar should be one formed at a comparatively low temperature, such as that produced from byproduct coke ovens or by gas plants which use no enriching materials for increasing the illuminating value of their gas.

2. A crude tar may be employed for this purpose because of its cheapness.

3. If not sufficiently fluid to apply cold, enough water-gas tar may be added to bring it to the proper consistency, but the proportion of the latter should not exceed 50 per cent of the mixture.

III. When used as a permanent binder for surface application either a crude or a refined product may be employed, preferably the latter.

1. If a crude coal tar is selected, it should have the following properties:

(a) Same as II, 1.

(b) Its specific gravity should be not lower than 1.15 nor higher than 1.19.

(c) It should be free from water-gas tar and oil tar.

2. If a refined tar is selected, the following might be specified:

(a) Same as II, 1.

(b) The specific gravity should be not lower than 1.17 nor higher than 1.20.

(c) No water nor ammoniacal liquor should be present, and the boiling point should be above 110° C. (230° F.).

(d) Upon distillation at least 40 per cent by volume of pitch should remain after all oils have been driven off below 270° C. (518° F.).

IV. When used as a permanent binder in road construction it is necessary that more binding base be present than is usually found in the crude product. A refined product should therefore be employed. This may either be prepared from a crude tar by the contractor or else a special preparation may be purchased.

1. In the former case a mixture may be prepared as follows from a crude tar, which meets the specifications set forth in III, 1:

(a) The tar should be heated until the boiling point is raised to at least 110° C. (230° F.).

(b) One-tenth part or more of good soft pitch should then be dissolved in the tar while hot. The quantity of pitch added should be sufficient to produce a pitch residue of at least 50 per cent by volume after all oils have been driven off under 275° C. (518° F.).

2. A refined tar for this purpose should meet the same requirements as suggested for III, 2, except that the pitch remaining after volatile oils under 270° C. (518° F.)

have been driven off should amount to at least 50 per cent by volume.

In some cases, especially where the climate is warm throughout the year, a tar considerably richer in pitch may be preferred. As a rule, low-temperature tars may conveniently contain more pitch than those produced at high temperatures, owing to the presence of a greater amount of heavy oils and a smaller amount of free carbon.

Labor Cost of Concrete Curb, Cement Side Walks and Brick Pavement at Gary, Ind.

BY E. M. SCHEFFLOW.*

The improvement of Madison St. at Gary, Ind., from the south line of the Wabash R. R. to the north line of the Pittsburg, Ft. Wayne & Chicago R. R., a distance of 3,800 ft., has been recently completed. The improvement consisted of brick pavement laid on a natural sand foundation with cement grout filler, 38 ft. wide, between curbs; concrete curbs 5 in. x 18 in., with 5 ft. radii at street intersections and cement sidewalk 5½ ft. wide. The grading was all done during the winter while the ground was frozen and all the material was hauled at that time. As there was no inspectors on the work at that time, no cost data are available for this portion of the work.

Cost of Placing Curb.—The mixture for curbs was 1:3:5 Portland cement, torpedo sand and broken limestone, with a facing 1½ ins. thick composed of 1:1:3 of Portland cement, sand and granulated granite. The concrete was mixed dry by hand and then mixed wet in a worm screw mixer operated by a gasoline engine. Wooden forms were used.

The labor cost was as follows:

	Total Per Lin.Ft.	
Laborers, mixing, 128 days at \$2.00	\$256.00	\$0.0351
Laborers, wheeling and tamping, 127 days at \$2.	254.00	.0348
Finishers, 51 days at \$5.50	280.50	.0383
Form setters, 80 days at \$3	240.00	.0330

Total, 7,268 lin. ft. . . . \$1,030.50 \$0.1412

Labor Cost of Laying Sidewalks.—The sidewalk was laid with a concrete foundation 3¾ ins. thick of the same proportions as that given for curbs and a wearing surface ¾ in. thick composed of five parts of Portland cement to seven parts of sand. The labor cost was as follows, the same method of mixing the concrete being used as for curbs:

	Total Sq. Ft.	
Laborers, mixing, 117 days at \$2.	\$231.00	\$0.0060
Laborers, wheeling, spreading and tamping, 112 days at \$2	284.00	.0073
Finishers, 47 days at \$5.50	258.50	.0066
Form setters, 37 days at \$3.	111.00	.0029

Total, 38,930 sq. ft. . . . \$887.50 \$0.0228

*Assistant City Engineer.

Labor Cost of Laying Brick Pavement.—

	Per Total Sq. Yd	
Laborers, preparing sub-grade, 13 days at \$2. . . .	\$86.00	\$0.0051
Laborers, carrying bricks, 326 days at \$2.	652.00	.0388
Brick layers, 53 days at \$3.50 per day.	185.50	.0112
One team, 3½ days, rolling, at \$5.50.	18.25	.0010
Laborers, mixing and spreading grout filler, 61 days, at \$2.	122.00	.0072
Total, 16,820 sq. yds. . . .	\$1,063.75	\$0.0633

The following table taken from the Canal Record summarizes the principal items of construction work accomplished on the Atlantic, Central and Pacific Divisions of the Isthmian Canal during the month of August:

Steam shovel excavation:

In prism, cu. yds.	1,834,479
Auxiliary, cu. yds.	46,773

Total, cu. yds. 1,881,252

Dredge excavation:

In prism, cu. yds.	1,375,991
Auxiliary, cu. yds.	61,448

Total, cu. yds. 1,437,439

Total excavation, cu. yds. . . . 3,318,691

Explosives used, tons (2,240 lbs.)	358.82
Drilling, feet	312,326.60
Track removed, miles.	7.07
New track laid, miles.	19.58
Material placed in dams, cu. yds.	64,109.
Rock crushed, cu. yds.	17,271.
Cement used, bbls.	97.
Concrete placed, cu. yds.	110.
New roads built, miles	.63
Water mains laid, ft.	4,527.
Open drains and ditches dug, ft. .	8,000.
Sewers laid, ft.	1,875.
Daily average number of laborers	13,284.

The Northwestern Cement Products Association will hold its 5th annual convention on Mar. 2, 3 and 4, 1909. The place where the convention will be held is to be determined later by a committee composed of J. C. Van Doorn, C. A. P. Turner, O. U. Miracle, R. O. Miracle and Harvey B. Smith. The association has decided to present to the Minnesota State Fair a concrete building to be used solely for cement product exhibits. A committee composed of the following members was appointed to select a site on the fair grounds for the building: H. A. Rogers, E. Cobb, J. C. Van Doorn, D. L. Bell. A committee to draw plans was also appointed consisting of the following men: C. A. P. Turner, O. U. Miracle, L. V. Thayer. The president of the association, Mr. Martin T. Roche, will act in conjunction with the different committees ex-officio.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Equipment of the Indiana Steel Co.'s Plant at Gary, Ind., for the Utilization of Blast Furnace Gas and Electrical Operations of Machinery.

The highest development in American steel works construction is exemplified in the large new plant of the Indiana Steel Co., at Gary, Ind. The entire power for these works will be supplied by internal combustion engines operating on blast furnace gas and this gas also forms the fuel for such few steam auxiliaries as are provided. All machinery will be operated by electric motors taking current from a central power station.

The significance of the foregoing statements will be clear to all who are familiar with steel mill practice; to those who have not this knowledge some notion of their

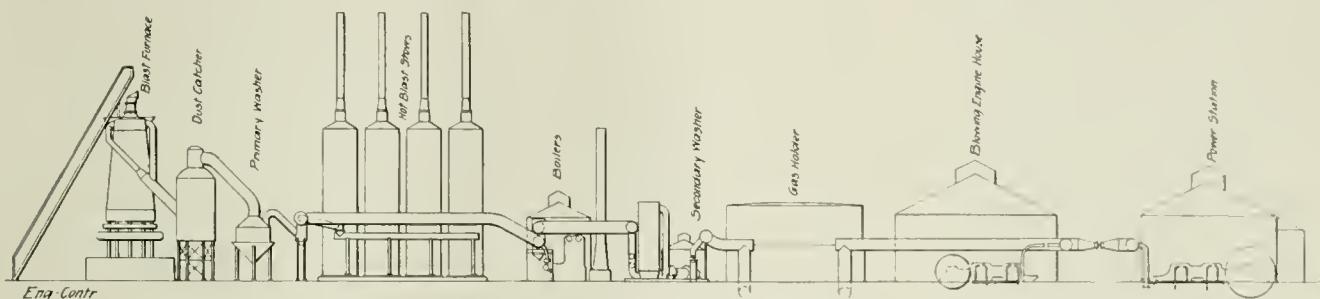
use of this gas approximately as follows: 30 per cent for treating the hot blast stoves, $7\frac{1}{2}$ per cent for fuel for steam boiler furnaces, 5 per cent for various auxiliaries and including the loss in working, $12\frac{1}{2}$ per cent for gas engine driven blowers, and 45 per cent for the main electrical power station.

Gas Washing.—The raw gas has to be prepared for use by washing it of its dust and impurities. This is done as follows: The gas from each furnace passes through four outlets, into two large pipes known as "downcomers," which lead into a reservoir, 30 ft. in diameter by 10 ft. high, called the "dry dust catcher." There, a considerable part of the impurities settles to the bottom, and the gas passes into another large pipe, which leads upward some distance to increase the quantity of dust dropped and then turns down again, empty

verted to special furnaces under a battery of Rust boilers used for making steam, and about 30 per cent is taken for heating the stoves. The remainder continues on to the secondary washers.

First of this group are the vertical scrubbers, drums about 11 ft. in diameter by 50 ft. high. A torrent of water cascades down through the drum, and from near the bottom of the drum comes the stream of gas against it. Rising to the top the gas again passes on into what are known as Thiessen washers, of which there are four to each pair of blast furnaces. In

each of these it is led between the wall of a cylinder and a revolving drum, armed with a series of paddle-like blades. A stream of water is spread into a film on the surface of the cylinder and the whirling drum throws such impurities as the gas still holds out against the water film, where they are caught and held. From these final washers the gas is conveyed under slight pressure to the holders, each of which has 200,000 cu. ft. capacity, from which it goes, as required, to the electric power station and blowing engine houses. The water for the various processes de-



Scheme of the Blast Furnace Gas Power Development of Indiana Steel Co., Gary, Ind.

significance may be had from the following brief explanation: When pig iron is to be made, coke, ore and limestone are put in layers in the blast furnaces and then the fires are lighted. A powerful blast of heated air is sent through the burning mass, in order to generate the intense heat necessary to melt the ore and the limestone, or "flux," into a molten mass. In the burning of the coke under a terrific forced draft, it is impossible to consume all of the heat energy in the coke. Despite the best engineering skill, all of the carbon in the coke cannot be made to unite with the oxygen in the blast, and, together with what is released in the burning of the limestone, it is carried away to the top of the furnace. The old way, in the early days of making iron, was to let all this gas escape into the atmosphere; later, a portion was caught and utilized for the generation of steam; and now in the Gary plant the entire volume of this waste is, for the first time, to be utilized.

There will be 16 blast furnaces at the Gary works and they will produce 11,000,000 cu. ft. of gas each 24 hours. This is the equivalent when used in gas engines of 500,000 hp. It is proposed to divide the

ing into a supplementary tank 11 ft. in diameter by 25 ft. high, one of which serves each pair of furnaces. This structure not only provides an additional dust catcher but also acts as a valve, being divided into two compartments partially filled with water. By increasing the height of the water in either compartment, the furnace on that side can be cut off as desired, and there will be no back flow from the mains beyond. The two chambers of this tank discharge into a pipe 10 ft. in diameter, which carries the gas and remaining impurities into the primary "wet" washers.

There are three primary wet washers to each pair of furnaces and each has capacity sufficient to take care of the gas from a single furnace, thus providing a spare washer for use while one is being cleaned or repaired. The primary washers are cylindrical in form, with cone bottom and cone top, and are about one-third full of water, a proper overflow maintaining the required level. Here the gas and dust is discharged against the surface of the water from pipes with fluted edges like a petticoat and escapes around these edges into openings from a larger main. At this point a small percentage of the gas is di-

scribed above is furnished by four large Platt turbine pumps.

Blowing Engines.—For the eight furnaces thus far erected there are two blowing engine houses. One is 600 ft. long and 101 ft. wide, and the other is of the same width but only 530 ft. long. The difference is due to the fact that the first-named house includes a central pumping and hydraulic power plant, equipped mainly by the Snow Steam Pump Works of Buffalo, N. Y. Besides gas engines each house contains two steam driven Tod blowers, but when the plant is in full operation, these will not be used. Each of the 16 blowing engines consists of a horizontal, twin-tandem gas engine of 2,500 hp, having cylinders 42 ins. by 54-in. stroke, and two direct driven blowing tubs having a capacity to deliver 30,000 cu. ft. of free air per minute against a pressure of 18 lbs. per sq. in. and so designed and proportioned that they can be operated at any pressure up to 30 lbs. The blowing tubs are of the Slick type. Eight of these engines were built by the Westinghouse Machine Co. and eight by the Allis-Chalmers Co.

Gas Engine Generator Sets.—The power station is 966 ft. long and 105 ft. wide. It

contains 17 horizontal tandem double-acting gas engines, turning at a speed of 83 1/2 revolutions per minute, 15 of which are designed for coupling to alternating current generators and 2 to be connected to direct current generators. The former are 25-cycle, 3 phase 6,000-volt machines, and the latter deliver current at a pressure of 250 volts. The engines have a rating of 4,000 hp. and the generators 2,000 k.w., but they are capable of carrying continuously 50 per cent overload. These are the largest engines in the world to operate on blast furnace gas. The 17 units were built complete by Allis-Chalmers Co.

The power generated will be distributed throughout the works and used to operate the heavy induction motor-driven rolls, the tilting and feed tables for the various passes, the hot saws, hot and cold pull-ups, hot rolls, transfer tables, straightening and drilling machines, cold saws, elevators, conveyors, pumps and a multitude of machines and mechanical devices auxiliary to the operation of such an enormous plant. Several of the motors built by the General Electric Co. for these works are of 6,000 hp. each, being designed for driving the rolls, and from this they range in size down to machines of the smallest capacity used to operate switches in the power house.

Open Hearth Furnaces.—Besides the improved blast furnace practice and the utilization of the resultant gas, the plant at Gary is designed for economical production of steel throughout the works in their entirety. In the open hearth furnace plant, for example, provision has been made for retaining the heat of the molten iron, and at the same time insuring more uniform quality of the ingots, by conveying it in 40-ton ladles, on special trucks, directly from the blast furnaces to mixers, shaped like converters, of which there are two, with a capacity of 300 tons each, in the north end of each of the open hearth furnace buildings. From these the molten metal is again poured into 40-ton ladles, carried by cranes to the furnaces and there emptied in by means of Wellman-Seaver-Morgan charging machines. This conserving of the heat of the iron, in addition to reduced operating costs and the fact that less machinery is required about an open hearth plant, represents in itself a notable economy.

The plans of the plant provide for six batteries of basic open hearth furnaces, 11 to the building, of which two batteries or 28 furnaces are at present constructed. Each of the open hearth furnace buildings will be 1,200 ft. long and built in three spans, giving a total width of 193 ft., with a height of 104 ft. above the floor line, thus allowing for excellent ventilation. The charging floors are of steel. Instead of being at right angles to the rest of the plant, the buildings run northeast and southwest at an angle of 35°. This is an innovation in the construction of a steel plant. Its benefit is to lessen the sharp

curve of the railroad tracks which run through the buildings.

At the north end of each building is a structure for the mixers, previously referred to, which is 120 ft. long by 86 ft. in width. This also contains a pit for relining ladles. Parallel to the furnaces is a leanto 21 ft. wide and running the entire length of the building, where the gas producers for the furnaces are located. Beyond the gas producers is a stock yard 72 ft. wide, every point of which is reached by overhead cranes. Between each pair of open-hearth buildings is a scrap house and skull cracker.

The open hearth buildings are liberally equipped with electrically operated cranes both traveling and fixed. There is one with a capacity of 125 tons in the casting department and another with a capacity of 125 tons on the charging side. The ladles handled in pouring off are of 86 tons capacity each.

With the four open hearth buildings, now completed or under construction, in operation, the Gary plant will have a capacity of over 12,000 tons of steel per day, or 2,500,000 tons per year. With all six buildings in use, the total capacity of the plant, as planned by the United States Steel Corporation, will be upwards of 4,000,000 tons per year.

While the furnaces are unusually large, being 40 ft. long by 16 ft. wide, they are excelled in a few plants, but for the size of the buildings themselves there is said to be no precedent in the world.

Each of the furnaces will be supplied with gas from a producer built by the Morgan Construction Co., the stacks having been furnished by R. Monroe & Sons, of Pittsburg, Pa.

As it takes about eight hours for a heat and the furnaces are never allowed to cool except for repairs, the daily capacity of each of the 70-ton furnaces will be about 210 tons, giving, with one furnace down for repairs, a total of 3,360 tons for each open hearth building daily.

Rail Mill.—The rail mill is the largest in the world. With everything running at top notch, 4,000 tons of steel rails can be produced daily, and in normal operation the mill is expected to turn out 100,000 tons per month. Although 18 passes are required for the complete metamorphosis of the ingot from bloom to finished rail, ready for cooling, so swiftly do the rails follow one another that from eight to twelve lengths are cut off by the hot saws at the end of the mill every 60 seconds.

The group of rail mill buildings is located about 300 yards from the lines of the open hearth furnaces. The main structure is 1,800 ft. long, and at right angles to it is another building of one-third the length, with a width in a single span of 85 ft. This contains twelve soaking pits or furnaces, each of which is supplied with gas from an independent Hughes mechanical gas producer. The arrangement here is such that ingots enter from the open hearth

furnace buildings along the entire length of one side of the pit building, the other side being reserved for the electrically operated ingot buggies which transfer the heated ingots through the first stand of rolls. Each of the twelve pits has four holes 6 ft. by 6 ft. and is provided with the usual equipment of hydraulic cylinder covers and reversing air and gas valves of the well known Dybbie type. The ingots used are 20 ins. by 21 inches and 6 ft. long, weighing 8,500 lbs. each. For the operation of the two ingot buggies used, Cutler-Hammer Mfg. Co., of Milwaukee, has developed an ingenious system of control. On account of the length of the building in which the soaking pits are located, it is impossible for the operator stationed at the mill to see when an ingot buggy is opposite a particular pit. It was, moreover, deemed necessary to guard against the possibility of the operator becoming confused and bringing both ingot buggies to the mill at the same time, which would result in a collision. The special controlling system provides guards against this contingency, at the same time enabling the operator to automatically stop the ingot buggy at any of the pits. There are two master levers for the control of the two buggies. Each of these levers can be set in any of eight positions, one corresponding to the rail mill itself, six to the six soaking pits, which each buggy serves, and one "off" position. If, when one of the ingot buggies is at the mill, the operator desires it to go to pit No. 5, let us say, and there stop, he merely moves the controlling lever to the position corresponding to pit No. 5 and the buggy proceeds to that point and is there automatically stopped. A suitable interlock between the two controlling levers is provided which renders it impossible for the operator to throw both levers to the mill position at the same time, thus insuring a clear track for each buggy.

The arrangement for receiving and handling coal through the gas producers is very complete and consists of an elevated track upon which the coal is received and conveyed to overhead storage bins; thence it is distributed to the various producers by means of a 5-ton crane equipped with automatic scales.

The rail mill is equipped with twelve sets or stands of roll trains, all operated at varying speeds by General Electric alternating current motors, some of which are of the largest sizes ever constructed for industrial service. These are housed in a separate bay or "leanto," running parallel with the rolls. The rotors are 20 ft. in diameter and have a speed of 83 revolutions per minute. All of the motors are connected directly to the roll trains by regular mill couplings. The aggregate driving capacity is 24,000 hp. Although the motors are provided with flywheels and operate in one direction, provision is made for reversing in case of necessity. The control system has been worked out with the greatest nicety, all operations being un-

der the instant control of the operator by means of a master controller.

The first group of rolls consists of four stands of continuous 40-in. mills, each two of which are driven by a 2,000-hp. motor. They are arranged in tandem requiring no manipulation from stand to stand. Here, as elsewhere through the plant, sufficient distance is left between successive sets of rolls to enable a quarter turn of the ingot or bloom to be made, so that it is worked equally on all sides. The first two mills are at present equipped with 42-in. rolls, enabling 20-in. by 21-in. ingots to be used. After passing these four mills the ingot is sent to a 40-in. three-high blooming mill equipped with lifting tables and arranged with a combined hydraulic and pneumatic balancing device. This mill, which is operated by a 6,000 hp. motor, gives the ingot five passes. After being bloomed the ingot is sheared in a 10 by 10-in. horizontal blooming shear, and the crop ends or butts are taken outside of the mill by a butt conveyor of unusual construction, which was designed and built by the engineers of the Indiana Steel Co. Each bloom then goes through a 28-in. roughing mill, which is three-high and equipped with tilting tables. This mill has actually three stands of rolls. The roughing stand, however, is the only one that is three-high, the other two stands being two-high. The mill is driven by a 6,000-hp. motor and gives the bloom three passes. After leaving the roughing mill the bloom goes through a two-high 28-in. forming mill driven by a 2,000-hp. motor, receiving but one pass. Then it is sent to finishing mills, which consists of five stands of 28-in. mills driven by two 6,000-hp. motors. After the dummy pass, the bloom is transferred to the first edging, which is in this same mill but the second stand, and turns back on an elevated table to the second edging, which is in line with the 28-in. roughing mill. It then travels by chain transfer to the lower tables and on the leading pass goes through a stand which is also in line with the roughing mill and driven by the same motor and continues on to the third stand of the 28-in. finishing mill, this being the eighteenth and last pass. After the finishing pass the rail travels through to the saws, of which there are five provided, thus cutting four rails to length. These four rail lengths consist of half the ingot. As the capacity of this mill is 4,000 gross tons per 24 hours it will be seen that there must be a four rail length sawed about every half minute. The saws are 42-in. blades, arranged to be raised and lowered in unison by one controller from the hot saw operator. After leaving the hot saw run the rolls pass over the usual cambering machine and are run onto hot beds 100 ft. long, of which four are at present installed, with provision made for an additional two, if necessary. These hot beds extend to the south of the mill proper. In the finishing mill section they are of unusual design, being made of

structural material and placed 8 ft. above the floor, allowing for an extraordinarily large air space to facilitate the rapid cooling of the rails. The finishing building is 1,383 ft. long, central with the hot beds and provided with live rolls extending the entire length. The roller tables are equipped with steps and kick-offs to transfer the rails to the straightening presses, of which there are 16, built by the Hilles & Jones Co., of Wilmington, Del., these being of the usual type and motor driven. From the straighteners the rolls are transferred by the usual skids to three-spindle vertical drill presses furnished by Wm. Sellers & Co., of Philadelphia, which are also motor driven. These complete the rails for use. From the drill presses the rolls are transferred to a roller table, which extends the full length of the building and from which the rolls may be skidded to the loading beds immediately outside of the building.

The principal machinery was built and installed by the United Engineering & Foundry Co., with the exception of the finishing department, which was erected by the Morgan Engineering Co. For the lifting tables and transfers Westinghouse motors are used.

In the rail mill a number of Cutler-Hammer automatic remote control devices are installed, the most interesting of which are those designed for the control of the elevating and tilting tables, the bloom shear and the transfer. The elevating table on the 48-in. blooming mill, weighing about 250,000 lbs., is supported on huge bell cranks which are connected to a rotating crank driven by a 250-hp. motor operating at 150 r. p. m. By means of automatic controlling devices the throwing of a master lever starts the table from the low level position and raises it to the highest level, where it is automatically stopped. In lighting the table from the low to the high level, the rotating crank moves through an arc of 180° and, on throwing the master lever to the reverse position, the crank revolves another 180° in the same direction, bringing the table to the low level once more. The operation of raising or lowering the table can be accomplished in a period of two seconds, which is quite remarkable when the masses to be accelerated, slowed down and stopped are considered. Its arrangement is similar to that of the elevating table, one end being pivoted and the other end supported on a bell crank. The tilting table is driven by a 150-hp. motor controlled by a controller similar to that designed for the elevating table. The bloom shear is operated by means of a 75-hp. induction motor and the pin on the clutch by a direct current auxiliary motor of 5 hp. The circuit of this motor is interlocked with the controlling device for the 75-hp. alternating current motor so that the former cannot be put in motion except when the latter is running at full speed. The latch is operated by a crank to which the 5-hp. motor is geared. Pressure on a push but-

ton under control of the operator causes the motor to run long enough to revolve the crank 300° , thereby releasing the clutch and returning the pin to the initial or "off" position.

Automatic controllers installed in connection with motors on the transfers make it possible for the operator to transfer the rail from one table to another by a simple throw of the lever, the motor being automatically stopped after the transfer has been completed.

For the operation of cranes, tables and other apparatus, in and about the rail mill, requiring direct current, two 500 kilowatt synchronous motors driving direct-current generators have been furnished by the General Electric Co. This equipment, with the necessary switchboards, is located in one of the motor houses at the rail mill and designed "Sub-station No. 1." Other substations suitably equipped are being located in other sections of the plant.

Loading Cars.—The loading yard is provided with the usual inspection beds and two tracks, each about 1,400 ft. long, connected with the track system of the plant at both ends, thus avoiding any unnecessary shifting. The yard is also served by an 80-ft. traveling crane for the entire length of the finishing department and by means of this the rails are placed directly on flat cars.

In loading steel rails the ordinary way has been to switch in on stub tracks, which require that the cars go out the same way. In the Gary plant the railroad tracks along the finishing department of the rail mills will be at a slight grade, so that they can be moved by gravity to the point where they are needed. The empty cars come in on one of the nine tracks forming the trunk line. They are then switched to tracks making a broad curve to the finishing department. As soon as loaded, they are sent down the tracks by gravity to the other end of the yard, where locomotives pick them up and haul them back to the trunk lines.

This movement of cars at the rail mill is typical of the plans of the entire plant. Everything keeps moving forward from the time the cars enter the great railroad system of the mills. There is little or no turning backward at any point. The movement is always forward. In this way the maximum capacity of service is secured and the danger of blockades reduced to a minimum. All of the butts and scrap from the rail mill are loaded into cars from the conveyor above mentioned and carried back to the open hearth furnaces.

Billet Mill.—The billet mill consists of four continuous stands of 40-in. blooming mills, each two of which are driven by a 2,000-hp. motor. After leaving these the ingot is turned end for end on a turn table and passes through a five-stand 32-in. continuous mill, the entire mechanism of which is driven by one 6,000-hp. motor. At the end of this mill is placed a 12 in. by 12 in. horizontal blooming shear and

also a 10-in. by 10-in. vertical blooming shear, from either of which shears either sale blooms or blooms for the 24-in. mill immediately following may be sheared. The sale blooms are run out on hot beds on the other side of the building where there is a loading yard equipped with overhead traveling cranes. Blooms intended to be further reduced after being sheared are sent through the 24-in. continuous mill, which consists of six stands driven by a 6,000-hp. motor, reducing the blooms to 4 or 5 ins. square. At the end of the 24-in. mill is placed a roller table. The billets may be transferred to an 18-in. continuous mill to be further reduced or, if for sale, to a shear, and from thence to overhead billet pockets from which they may be loaded directly into cars.

For the further reduction of billets taken from the above mentioned transfer skids the billets are run through an 18-in. six-stand continuous mill, driven by a 6,000-hp. motor and equipped with flying shears, so that billets reduced in this mill (1½ in. and 2 in.) may be run out on covered hot beds extending at right angles to the general direction of the mill into an extension of the same billet loading yard as that provided for the 10-in. and 12-in. sale blooms. Provision has also been made for the installation of an additional continuous mill for reducing 4-in. and 5-in. blooms to such small sections as the trade may require. This mill will be located on the opposite side of the mill building from the 18-in. mill, thus providing additional capacity to take care of the enormous tonnage from the blooming mill proper.

All of the machinery is electrically driven, General Electric, Crocker-Wheeler and Westinghouse motors being used. This machinery was also furnished by the United Engineering & Foundry Co.

The ingots for this billet mill are heated in twelve soaking pit furnaces of approved design, arranged similarly to those adjoining the rail mill. Each of the pits in both buildings is supplied with gas from one independent Hughes mechanical gas producer built by the Wellman-Seaver-Morgan Co.

An interesting feature of the billet mill is the handling of the scale. Usually in a mill of this size the problem is a serious one, but here means have been provided by which all of the scale from the various mills is collected in a large pit extending for some distance along the side of the building, whence the scale can be removed at any time without interfering with the operation of the mills.

Additional Mills.—The additional mills to be built are a 60-in. universal plate mill, which will be the largest of its kind in the world, and a 41-in. by 160-in. sheared plate mill. These two mills will each be served by a 32-in. slabbing mill. Further extensions to the Gary works include an axle mill, structural mill and 18-in., 14 in., 10-in. and 8-in. merchant mills.

The mill buildings are steel frame with brick sides and corrugated iron roofing.

The open hearth, stripper and soaking pit buildings have steel frames with corrugated sides and roofings. The structural steel here and elsewhere in the plant was furnished by the American Bridge Co., supplemented by the Illinois Steel Co.

Harbor.—The harbor consists of a deep water slip and turning basin, 750 ft. in diameter, built by the Great Lakes Dredge & Dock Co., ample for the accommodation of the largest ore carrying boats. From this basin a channel 250 ft. wide, with a depth sufficient for the largest freighters, has been dredged as far as the straightened and deepened channel of the Grand Calumet River, and lined with concrete docks 62 ft. wide. On the side towards the mills these extend for a mile, rising ten feet above datum or the normal water level.

The plant for handling ore from the vessels consists of five Hulett unloaders and Hoover & Mason bridges of sufficient capacity to furnish material for the eight blast furnaces already built, each of which will deliver 500 tons of pig iron daily, and the eight additional furnaces yet to be constructed.

From the time the steamer, with its 10,000 or 12,000 tons of cargo, reaches the harbor, every detail of handling the ore is a purely mechanical process. In his little house on the vessel-unloader one man does the work of several score under the old system of handling ore with shovel and hoist. The clam-shell, designed to carry five tons, is dropped into the hold of the steamer, automatically seizes its load, raises it and swings it around, dumping into large concrete ore pockets at the rear. This operation takes less than a minute.

From the pockets, which have walls 5 ft. to 8 ft. thick with concrete bottom 5 ft. above lake level, the ore is taken, as required, by grab buckets operating on bridges 498 ft. long, which are the largest ever constructed, rising to a height of 85 ft. above the floor of the ore pockets. Each is equipped with clam-shell, carrying 14 tons at every trip. By means of the bridges ore is conveyed to hoisting bins, divided by concrete walls spaced 87 ft. apart, which are built or laid out for nearly a mile parallel to the dock, and, with the pockets at the water line, have a present capacity of over 1,000,000 tons, sufficient to supply the furnaces during five months or more of closed navigation. With the completion of the bins this storage volume will be about doubled. By means of auxiliary track facilities, provided for handling ore in and out of cars, the entire system is also rendered exceedingly mobile. From the bins the ore is taken by electrically operated larries and hoisted on skips to the tops of the blast furnaces.

The ore bins and auxiliary apparatus were constructed by the Brown Hoisting Machinery Company of Cleveland, Ohio, except the electric hoists operating the skids to the blast furnace tops, which are

of the Onis Elevator Co.'s standard design for this service.

Shops and Buildings of General Utility.—In connection with the furnaces and mills of the steel plant proper there have been erected a group of buildings of general utility, consisting of a machine shop, foundry, boiler shop, blacksmith shop, pattern and carpenter shop, pattern storage building, roll shop, electrical repair shop, brick storage house and a very well equipped general store house. These shops are of steel frame construction with brick walls and concrete tile roofing. There has also been provided a yard locomotive house, which is rectangular in shape, with tracks running through on an angle from one side to another, thus avoiding the use of a turn table.

Railway Facilities.—The Chicago, Lake Shore & Eastern Ry., which runs its lines directly into the plant of the Indiana Steel Co., is owned by the United States Steel Corporation. In 1907 it carried 12,751,000 tons, and, with the completion of the Gary mills, this will be increased at the outset to not less than 20,000,000 tons. It has 130 locomotives and over 10,000 freight cars in operation and, in connection with the Elgin, Joliet & Eastern Ry., also owned by the Steel Corporation, forms a belt line completely around Chicago, connecting with all of the great trunk lines centering at the foot of Lake Michigan and finally reaching the lake again at Waukegan, Ill., about 30 miles north of Chicago.

When the site for the new plant for Gary was selected, it was found that the main line of the Baltimore & Ohio and Indiana Harbor railways would run through the center of where the great mills are now located. It was therefore necessary, in order to build the plant at this particular place, to change the location of these two roads, and also, in carrying out the general scheme of the Steel Corporation, to alter the route of the Lake Shore & Michigan Southern Ry.

A new line was built for the Lake Shore & Michigan Southern Ry. and is now in operation by that road for a distance of about 14 miles, the old tracks having been taken up.

A new double track road was also constructed for the Baltimore & Ohio Ry. from Indiana Harbor to Millers, Ind., a distance of 12 miles, and one of 7 miles for the Indiana Harbor Road to take the place of its old line.

All these railroad changes were necessary in order to lay out the steel plant, freight yards and railroad facilities of the Chicago, Lake Shore & Eastern Ry. These newly constructed lines have all been elevated through the city of Gary, so the question of track elevation is, for this community, a matter of the past and not of the future.

Terminal Yards, Shops, Etc.—The location of the plant, with direct access to all railroads, through the United States Steel

Corporation's own line, also requires typical classification yards such as are met with only near large centers of population. These are known as the "Kirk" yards. They are designed to accommodate 15,000 cars and interchange yards being built by connecting lines will hold fully 10,000 more. In them the millions of tons of freight handled in and out of Gary yearly will be made up into outgoing trains or classified for switching to various parts of the steel plant. Like the mills, they are laid out on the unit system and up to the present time about one-half of the work has been completed. In addition to its trackage the yard now contains a locomotive round house, car repair shops, sand houses, coal bunkers and fire pits for cleaning the engines. All of the rolling stock of the Chicago, Lake Shore & Eastern Ry. will be cared for here.

Inter-works Transportation.—Within the plant itself no feature has had more careful thought bestowed upon it than that of inter-works transportation. The lines from the railroads enter the mills at the southwest corner, through the "Kirk" yards, over nine main tracks crossing on a viaduct. These, upon entering the grounds, branch out to the shops, rail mills, open hearth furnaces and finally to the blast furnaces. To reach the furnace there is a long trestle carrying tracks at a considerable elevation, also trestles to the gas producers of the soaking pit buildings, for the coal handling system above described. Around the open hearth buildings there is a perfect network of tracks, crossing and recrossing, and on the charging floor of each three standard gauge tracks come in on a long embankment from the north. The chief end sought was to secure direct access to every part of the plant by the most available route, with no chance of blockades. If an engine with loaded cars cannot reach any desired point in one way it can get to it from another. No intricate problem was ever worked out with more painstaking care than this one of handling iron from the blast furnaces to the open hearths, from the open hearths, as stated, to the mills, and from the latter to outgoing lines for shipment, with a minimum of retrograde movement.

The system of handling cars at the rail mill, which has already been described is also true of the other mills.

On the dock and walls of the ore pockets are laid tracks upon which the ore unloaders and bridges travel, giving them a working range of nearly a mile along the blast furnace fronts, and parallel with these run four switch lines, enabling ore or other material to be unloaded from vessels directly into cars when shipment is to be made elsewhere.

Along the ore bins tracks extend their full length, so that, when it is not desirable to move the great bridges, the ore can be unloaded directly into cars, moved to any section required, shot into the ele-

vator boots and hoisted to the tops of the furnaces.

The railroad system of the mills alone has a trackage of about 100 miles, and the Kirk yards have 125 miles, making 225 miles in all. Besides the large number of standard locomotives of the Chicago, Lake Shore & Eastern Ry., there are required to handle the inter-yard traffic 40 light locomotives of the type built by H. K. Porter & Company of Pittsburg, Pa.

In the transportation and handling system of the plant large traveling cranes, up to 125 tons capacity, as well as jib cranes, are prominent. These were supplied by the Morgan Engineering Company, the Whiting Foundry Equipment Company and the Alliance Machine Company. They are supplemented by a number of locomotive cranes built by the Industrial Works, Bay City, Mich.

Amount of Work Done Per Man in a Large Bridge Works.

At the Pencoyd works of the American Bridge Co. the following was the amount of work done in the first half of the year 1901: The number of men employed was 765 (of whom 98 were draftsmen) and the output was 82,600,000 lbs. in 6 mos., or nearly 13,800,000 lbs. per mo. The average output per man per month was, therefore, 18,300 lbs. The output of each of the different classes of men was as follows per month:

	Pounds.
Draftsmen (98 men).....	140,000
Templaters (30 men).....	455,000
Bridge shop.....	21,300
Forge	11,000
Eye-bar shop.....	35,400

The output per draftsman was found by dividing the total output of the works by the number of draftsmen employed; in like manner the output per templater was calculated; but the output of each man in the bridge shop, forge and eye-bar shop was calculated only on the basis of the number of pounds handled in each of those departments.

The Detroit & Mackinac R. R. is said to be planning to operate a continuous farm along its right of way next year. It proposes to cultivate the land on each side of its tracks, planting a diversity of crops. It has a two-fold purpose in adopting this plan. In the first place, it wishes to impress passengers on its trains and intending settlers in its territory what can be done with the soil. The second reason is to avoid the numerous fires which are started along the line, especially in the fall of the year, by sparks from locomotives. The road also will operate a model 40-acre farm at Emery Junction.

The total production of coal in the United States in 1907 was 180,363,424 short tons, having a spot value of \$614,788,898.

The Proposed Extension of the Chicago Drainage Canal as a Deep Waterway to the Illinois River.

As the preliminary step to state aid towards the extension of the Chicago Drainage Canal as a deep waterway, the people of Illinois will vote at the November election on a constitutional amendment permitting by action of the legislature the issuance of bonds not exceeding \$20,000,000 in amount for construction. That the voters may have some definite information on which to base their action the Internal Improvement Commission charged with the duty of preparing preliminary plans and estimates has issued a statement of the work proposed. This commission is composed of Mr. Isham Randolph, M. Am. Soc. C. E., of Chicago, Mr. H. W. Johnson, of Ottawa, Ill., and Mr. H. M. Schmoldt, of Beardstown, Ill., and its statement is as follows:

Starting at the sanitary district powerhouse below Lockport and 36 miles from Lake Michigan, it is proposed to lock down into the Joliet pool level through a lock with a 34-ft. lift, and to continue this level through Joliet to the head of Lake Michigan at approximately mile No. 12. At this point will be located the first water-power development, with a head or fall of 24 ft., and a gross horse power available of 38,182 with the ultimate flow of 11,000 cu. ft. per second.

Lock No. 2 will carry the water way through this 24-ft. fall into the next level, which extends for 14 miles to a point just below the mouth of the Kankakee river, where, at mile No. 56, will be located the second power plant with an available head of 18 ft. and a water power potential of 28,636 gross horse power.

Here the water way is carried through lock No. 3 down the fall of 18 ft. into the next level, which extends for 27 miles to a point about 3 miles below Marseilles, where at mile No. 83 will be located the third power plant, with an available head of 26 ft. and a water power potential of 41,564 gross horse power.

Here the water way is carried through lock No. 4 down the fall of 26 ft. and into the next pool level, which extends for 14 miles to a point just above the Utica wagon bridge, where, at mile No. 98, will be located the fourth and last power plant, with a head or fall of 20 ft. and a water power potential of 31,818 gross horse power. The water way is carried through a lock at this point down the 21-ft. fall and into the Illinois river at La Salle, where the state will leave it to federal development and control.

The locks, as designed, are to be 800 ft. long, center to center of quoins, 50 ft. wide and with 24-ft. of water over the miter sills. These dimensions are in excess of present-day requirements, but it is the policy of this commission not to limit future development by the works which it may now be expedient to construct.

At points where it becomes necessary to cut a new channel the minimum bottom width will be 300 ft., but the longest stretches of the water way will be wide, deep pools formed by the dams and admirably adapted to a shipway. It is proposed to give this channel at points where excavation is necessary (and the excavation required is small) a preliminary depth of 14 ft., and to increase this to an ultimate depth of 24 ft. when the need becomes apparent and the money available. It is to this ultimate end that the locks are designated with 24 ft. of water over the miter sills.

A summary of the water power developed is as follows:

Gross H. P.

Plant No. 1.....	38,182
Plant No. 2.....	28,636
Plant No. 3.....	41,364
Plant No. 4.....	31,818

Total 140,000

The net salable power may safely be taken as 100,000 h. p., and a conservative rental for 24-hour power is \$25 per horse power per year in excess of operating expenses. The annual net revenue will therefore be \$2,500,000.

As a navigable water way the completed channel will be under federal control, and it is quite probable that the state can secure federal co-operation in the construction of the locks and the dredging of the channel, thus decreasing materially the cost to the state and increasing the net revenues from the sale of power. This is a matter for congressional action, however, and we have taken no account of it in these preliminary estimates.

This commission estimates the cost of this construction as follows:

For a 14-ft. preliminary water way with locks 24 ft. deep, for construction only	\$14,318,986
Cost of developing 140,000 gross horse power, four power houses and equipment complete	3,600,000

Total construction cost of water way and water power.....	\$17,918,986
Right of way.....	340,000

Total cost of water way and water power	\$18,258,986
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Income Account:	
Power rentals, 14 years at \$2, 500,000 a year	\$35,000,000
Interest income on sanitary fund	3,355,694

Total	\$38,355,691
Interest charges on bonds, 14 years	11,200,000

Left for sinking fund.....	\$27,155,694
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Summary:	
Sinking fund accumulation.	\$27,155,694
Interest on bonds during construction per-	

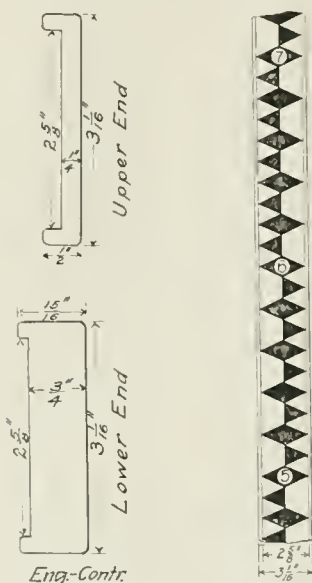
iod, 6 years at 4 per cent	\$ 4,800,000
To retire bonds	20,000,000
	21,800,000

Balance earned over and above cost of water way and water power	\$ 2,355,694
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These estimates are made from exhaustive computations on the most complete data by competent engineering authority, and the total is a maximum cost, 10 per cent having been added for contingencies.

The improvement can be made in five years, and allowing one year for delays, the water power will begin to show earnings in the seventh year. The bonds will be sold only as the funds are needed, and the interest charge will be cumulative during this period, reaching the total of \$800,000 a year at the end of the sixth year, when all the bonds are afloat.

Assuming that the entire issue were sold



Home-Made Stadia Rod.

at the start, \$800,000 a year must be paid for interest at 4 per cent. The surplus earnings should go into a sinking fund and bear interest at not less than 2 per cent. On this basis there would be advanced by the state in the six years before the plants began to show earnings \$4,800,000 interest on the bonds. Beginning with the first year that shows a return on the investment, the foregoing schedule gives the yearly earnings and accumulations of the sinking fund.

The bonds must be retired after 14 years of operation, and as shown by the foregoing summary, the entire issue can be retired with a net profit to the state of \$2,355,694. This presents the case in its most unfavorable aspect. And this is not all; for this property will continue to yield its perpetual yearly revenue of \$2,500,000, increasing in value with the increase in cost of fuel.

Home-Made Stadia Rod.

BY J. C. BLACK.*

Having had occasion recently to do some stadia surveying, and not being crowded with work at the time, I decided to manufacture my own rod. The rod was of ash 12 ft. long by 3 1/16 ins. wide. I obtained the material at a carriage shop, and had it cut to the desired cross section at a local planing mill. This left all the corners sharp, but a little sand papering quickly rounded them. The rod tapered uniformly from 3/4 in. thickness at the bottom to 1/4 in. at the top, and was finished on the lower end by heavy sheet brass bent up the sides and edges for 2 ins. and fastened by small brass screws. The beaded edge shown in the drawing was beveled off at the bottom to avoid danger of splitting. The top was finished by a piece of brass 2 5/8 ins. wide by 1 1/4 ins. long bent squarely over it and fastened by four screws.

A stiffening cleat or rib on the back would have been an improvement, as the rod lacked rigidity in a wind. The total weight as finished was a little over 7 lbs.

The back and edges of the rod were oiled but not painted or varnished. The face was marked with a pattern similar to one used by the U. S. Coast Survey. Three coats of white paint were given and two of white enamel, after which the outline of the pattern was marked by a light cut in the enameled surface. Only one coat of black enamel was necessary. Twenty-four hours was given for the drying of each coat, and this proved none too much. Although less than a third of the paint and enamel purchased was used, its entire cost and the brushes is charged against the rod.

Since most of the work was done at odd moments in the evening, the time consumed was of very little cash value, but for the sake of a working basis, a rate of 50 cts. an hour is assumed. The cost itemized was as follows:

1 piece ash lumber, 1 in. x 3 1/4 ins. x 12 ft.	\$0.80
Mill work	0.60
White paint	0.25
White enamel	0.25
Black enamel	0.25
Oil	0.10
2 brushes	0.25
Sheet brass and screws.....	0.20
Car fare	0.10
Total	\$2.80

Time:	Hours.	
Designing	1	\$0.50
Purchasing materials, etc.....	2	1.00
Rounding corners and sandpapering	1 1/2	0.75
Finishing ends	1/2	0.25
5 coats white paint and enamel..	1	0.50
Marking pattern on rod.....	1	0.50
Painting design in black.....	3	1.50
Total	10	\$5.00
Total cost of rod.....		\$7.80

*Vallejo, Cal.

Methods and Costs; Some Old; Some New.

Sampling Cement.—During 1907 the Materials Laboratory of the Sewerage Commission of Baltimore, Md., tested 47,420 bbls. of cement. In sampling the cement, the samples are placed in a tight moisture proof jar and brought to the laboratory for analysis. A printed card giving the laboratory lot number and the car number is placed on each bin in which cement is stored. A sign, padlocked to a wooden frame, reading "Hold" and "Released" on the front and back is also placed on the bins. When a lot of cement is sampled this sign is placed so as to read "Hold." After the cement is tested and accepted the sign is reversed so as to read "Released." By means of these signs an inspector can tell at a glance whether or not the contractor is using cement that has been tested by the laboratory and accepted by the Division Engineer.

Resetting Boundary Line Monument.—One of the monuments on the New York-Pennsylvania state line was moved from its original position and had to be reset. This was done by first placing an iron plate 6 in. in diameter and 1 in. thick, with a ¼ in. hole, in its center, 4 ft. 6 in. deep; the plate was set by transit from the line established as shown in the accompanying sketch. The stone was set in the same manner, its top being 3 in. above the surface of the ground. To establish the line, the alignment of



stones A, B, and C was tested and they were found to be in line. A, B and C being on a tangent, it was assumed that E was on the same tangent, as shown on the original maps, monument E being in good condition. After prolonging the line to D, the monument was reset. As there were obstructions between E and D, a line was run from E to f and the angles E f D and E D f and the distance E f were measured. Then the distance ED was computed and found to be 5,630 ft.

Taking Elevations.—In order to obtain the data for computing quantities for excavation and embankment for the Black River Disposal Works of the Sewer system of Baltimore, Md., elevations were taken on the four corners of 25-ft. squares over the entire area to be graded. This necessitated taking elevations at about 10,600 points. For doing this work stakes were set by the transit at the four corners of each 100-ft. square.

In taking the levels a piece of cord 100 ft. long, with red flannel tied at 25-ft. intervals, was used. Two men at the ends of this cord, starting from 100-ft. stations, paced 25-ft. intervals to the next station. At each of these intervals a rodman held his rod on the 25-ft. points along the string indicated by the pieces of red flannel. By this method a party of four men was able to secure elevations on about 1,000 points a day, representing an area of about 13 acres. At the same time these elevations were being taken the location of the wooded areas and partially cleared areas was accurately obtained. These data were plotted to a scale of 40 ft. to the inch on sheets covering an area of 1,000 ft. by 1,500 ft., and the excavation for each 100 ft. square figured on a separate sheet of paper, which greatly facilitated the work of making the monthly estimate for the contractor.

Placing Concrete in Freezing Weather.—In the construction of an ore dock the concrete was all placed during the winter season and considerable difficulty was experienced in getting the cement to set in the cold water. This was finally accomplished, however, by raising the temperature of the water from near the freezing point to about 45 degrees F. The water between the parallel sides of the timber crib was confined lengthwise of the crib by movable partitions which were set about 50 ft. ahead of the concreting and moved ahead as the work progressed. Into this body of water about 18 ft. wide by 50 ft. long, steam was discharged through a steam hose under pressure of about 60 lbs. This plan was very successful and enabled the cement to obtain its initial set before the movement of the water separated it from the aggregate. The heads of the piles projected about 1 ft. above the rock filling the crib, and, as an additional assurance that the cement would not be withdrawn from the concrete before setting, burlap was sunk on top of the rock fill around the heads of the piles to give the loose concrete some support while setting. The water was about 3½ ft. deep above the tops of the piles, and the concrete was deposited under water by means of a bottom-dump steel bucket which deposited it in place with very little opportunity for the water to separate the materials. The lower 4 ft. of concrete, it was found necessary to keep some distance in advance of the top course, and to insure bond between the two courses, steel dowels were placed as the work progressed. To insure against cracking, 1-in. round rods were embedded longitudinally of the foundation in the first concrete deposit above water and the expansion joints were begun a short distance above the rods. So far no expansion or settlement cracks have appeared.

and the work appears to be very satisfactory. Concrete below water was a 1:2:4 mixture of Universal Portland cement with pit sand and broken trap rock; that above water was 1:2½:5.

Cost of a Railroad Re-Survey.—In a paper read before the Ontario Land Surveyors' Association, Mr. W. E. McMullen, describes a re-survey of the Canadian Pacific Ry. line in New Brunswick, and the following notes have been taken from his paper: The general scheme of the survey was to make a center line traverse and tie in right-of-way fences, lot lines, parish and county boundaries, locate the properties of the various owners along the line, run rail levels, obtain approximately the original ground line, and note the dimensions of culverts, etc. For the field work two box cars were fitted up. The one with bunks and a drawing-table, and the other with a dining-table, stove, and quarters for the cook. The party was composed of an engineer in charge, transitman and two picketmen, a draftsman, a leveller and rodman, and three chainmen, who went ahead and paint-marked one rail every hundred feet. These last could cover eight or nine miles a day without much trouble, and, after getting their work well ahead of the party, were recalled to locate right-of-way, fences, culverts, etc. The leveller would cover about 4½ miles per day, and when he got too far ahead of the transit was recalled and ran a spare transit for a while. The transitman was paid \$75 per month and draftsman the same; leveller, \$60, and the others, most of them engineering students, \$1.35 per day. The cook got \$40 per month. The average progress of the field work was a little over two miles a day, and the average cost of the field work, exclusive of car furnishings and inclusive of wages and board, was \$14 per mile. The cost of fitting up the cars with stoves, bunks, blankets, mattresses, tables, dishes, etc., amounted to about \$150.

The locomotive equipment owned by the Isthmian Canal Commission consists of the following:

French	124
Decauville	9
200-class	100
300-class	40
600-class	20
36-in. gage	4
Total	297

The Belgian Ministry of Railways is considering the question of abolishing all grade crossings on Belgian lines. It is estimated that the entire sum needed to meet the expenses that such a measure would entail would be \$60,000,000. At present there are about 6,125 grade crossings on the Belgian lines.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0917. **Metal Shingles.**—The National Sheet Metal Roofing Co., 339 Grand St., Jersey City, N. J.

A neatly printed 32-page catalog telling of the merits of Walter's metal shingles and tiles for roofing purposes. Photographs are shown of buildings upon which they have been used, and shingles, ridge protectors and flinks and vanes are illustrated. A price list is given in the back of the pamphlet.

No. 0918. **Roofing.** Stowell Mfg. Co., 459 West Side Ave., Jersey City, N. J.

A 32-page catalog telling of the Monarch roofing, a ready roofing made from Trinidad natural asphalt. The various styles of roofing are shown and also uses to which they have been put. Also roofing accessories, such as metal paint, roofing cement, nails, and asphalt coating. A useful catalog of ready roofing.

Personals.

Messrs. D. C. and Wm. E. Jackson, Engineers, have opened an eastern office at 81 State street, Boston, Mass.

Mr. W. S. Davis has resigned his position as City Engineer of Huston, La., and will engage in railway engineering work.

Mr. Charles Wilkerson, heretofore a draftsman in the City Engineer's Department of Springfield, O., has been promoted to the position of Assistant Engineer.

Mr. A. N. Fitzsimmons has succeeded Mr. George C. Marsh as Sales Manager of the T. L. Smith Co., and as Manager of the Chicago office.

Mr. W. M. Kennedy, heretofore Division Engineer of the Pennsylvania Division of the Lehigh Valley R. R., has been appointed Division Engineer of the enlarged Wyoming Division of that road.

Messrs. J. H. Collins, A. H. Gilman and W. L. Dorkland, of Pueblo, Colo., have organized the Welton Construction Co. and will engage in the construction of ditches and reservoirs for irrigation purposes.

Mr. Paul L. Wolfel, for a number of years associated with the Peneoyd Iron Works and later with the American Bridge Co., has been appointed Chief Engineer of the McClintic-Marshall Construction Co., with headquarters at Pittsburg, Pa.

Messrs. F. W. Scarborough and C. K. Howell have associated themselves under the corporate name of Scarborough & Howell, Inc., and have opened offices at Richmond, Va., where they will engage in the practice of engineering and architecture.

Mr. C. R. Robinson, formerly Sales Agent for the Inland Steel Co., of Chicago, resigned Oct. 3d to accept the position of Chicago representative for the Lackawanna Steel Co., under the title of District Sales Agent, with offices in the Commercial National Bank Bldg., rooms 1726-1728.

Col. W. H. Bixby, Corps of Engineers, U. S. Army, who has been at Chicago for some time, has been transferred to the U. S. Engineer Office at St. Louis, Mo. He is succeeded by Maj. Thos. H. Rees, Corps of Engineers. Major Rees will have charge of the river and harbor improvements of Chicago, Calumet, Michigan City and all intermediate points along the lake front of Lake Michigan.

William Keuffel, President of Keuffel & Esser Co., died Oct. 1, at his home in Hoboken, N. J., aged 70 years. Mr. Keuffel was born in Walbeck, Germany, and received his education in the public and private schools of that place. When 15 years of age he left school and became an apprentice in a general merchandise store where he remained for four years, receiving a thorough mercantile and business training. He next entered the employ of a large hardware house in Hannover, Germany, and several years later went to Birmingham, England. In 1866 he came to the United States and, in the following year, together with his friend, Herman Esser, founded the firm of Keuffel & Esser, the first in this country devoted exclusively to supplying the requirements in office and field of the surveyor, engineer, architect and draftsman. Mr. Keuffel has resided in Hoboken almost from the day he landed in America. He was for many years president of the Hoboken Academy, a German-American school, and was a member of the Technischer Verein.

Bids for Constructing the Jawbone Division of the Los Angeles Aqueduct.

Elsewhere in this issue mention is made of the suit brought against the Board of Public Works of Los Angeles, Cal., to enjoin them from constructing the Owens River Aqueduct by day labor. Bids for the Jawbone Division were received on July 17, and all bids rejected, the work being undertaken by day labor. In order to afford a comparison of the contractors' bids and the engineer's estimate, the bids are given below.

Item	Class and Estimated Quantities.	Unit.	Price	Bid of Atlantic Gulf & Pacific Co.	Bid of McArthur Bros. Conditional on two sections being awarded to bidder	Bid of McArthur Bros. Conditional on all sections being awarded to bidder.	Bid of John Moran. Conditional on all sections being awarded to bidder.	Bid of Robert Shearer.	Bid of P. J. Moran. Conditional on all sections being awarded to bidder	Engineer's Estimate
Section 1.				Single Sections.	Sections 2 and 3	Sections 1, 2 and 3	Single Sections	Sections 1, 2 and 3.	Single Sections.	Sections 1, 2 and 3.
1	Completed and Lined Tunnel, 5,583 Lin. Ft.	Lineal Foot	Unit Price	36 70	30 00	23 036	22 50	18 00	38 50	16 26
		Foot	Amount	204,896 10	167,490 00	128,609 99	125,617 50	100,494 00	214,945 50	90,780 00
2	Canal Lining with Cover and Backfill, 38,115 Lin. Ft.	Lineal Foot	Unit Price	8 90	12 00	6 721	6 721	8 84	15 79	4 51
		Foot	Amount	339,223 50	457,380 00	256,170 92	256,170 92	336,936 60	601,835 85	171,900 00
3	Excavation, 223,970 Cu. Yds.	Cubic Yard	Unit Price	40	75 00	1 066	1 066	42	1 91	30
		Yard	Amount	89,588 00	167,977 50	238,752 02	238,752 02	94,067 40	427,782 70	67,191 00
4	Plain Concrete in Piers and Culverts, 328 Cu. Yds.	Cubic Yard	Unit Price	12 00	10 00	9 10	9 10	11 00	25 00	5 62
		Yard	Amount	3,936 00	3,280 00	2,984 80	2,984 80	3,608 00	8,200 00	1,843 00
Total.				\$ 637,643 60	\$ 796,127 50	\$ 626,517 73	\$ 623,525 24	\$ 535,106 00	\$ 1,252,764 05	\$ 331,714 00
Section 2.				Single Sections.	Sections 2 and 3	Sections 1, 2 and 3	Single Sections	Sections 1, 2 and 3.	Single Sections.	Sections 1, 2 and 3.
5	Completed and Lined Tunnel, 20,675 Lin. Ft.	Lineal Foot	Unit Price	54 50	44 00	44 00	36 984	36 70	40 00	51 95
		Foot	Amount	1,126,787 50	909,700 00	909,700 00	764,664 87	758,772 50	827,000 00	791,553 00
6	Canal Lining with Cover and Backfill, 6,542 Lin. Ft.	Lineal Foot	Unit Price	7 80	12 00	11 50	7 474	7 00	9 00	20 79
		Foot	Amount	51,027 60	78,504 00	75,233 00	48,901 45	45,794 00	58,878 00	136,008 13
7	Excavation, 33,800 Cu. Yds.	Cubic Yard	Unit Price	75	1 25	1 25	1 621	1 621	1 09	5 00
		Yard	Amount	25,350 00	42,250 00	42,250 00	54,925 00	54,925 00	36,842 00	169,000 00
8	Plain Concrete in Piers and Culverts, 334 Cu. Yds.	Cubic Yard	Unit Price	12 00	10 00	10 00	9 10	9 10	11 00	25 00
		Yard	Amount	4,008 00	3,340 00	3,340 00	3,039 40	3,039 40	3,674 00	8,350 00
9	Rubble Concrete, 1,800 Cu. Yds.	Cubic Yard	Unit Price	10 00	6 00	6 00	7 80	7 80	7 50	21 00
		Yard	Amount	18,000 00	10,800 00	10,800 00	14,040 00	14,040 00	13,500 00	37,800 00
Total.				\$ 1,225,173 10	\$ 1,044,594 00	\$ 1,041,323 00	\$ 885,570 72	\$ 875,570 90	\$ 939,849 00	\$ 1,425,224 38
Section 3.				Single Sections.	Sections 2 and 3	Sections 1, 2 and 3	Single Sections	Sections 1, 2 and 3.	Single Sections.	Sections 1, 2 and 3.
10	Completed and Lined Tunnel, 17,400 Lin. Ft.	Lineal Foot	Unit Price	52 80	43 50	43 50	33 384	33 30	36 75	51 95
		Foot	Amount	918,720 00	756,900 00	756,900 00	580,881 60	579,420 00	639,450 00	903,930 00
11	Canal Lining with Cover and Backfill, 16,000 Lin. Ft.	Lineal Foot	Unit Price	8 60	12 00	11 50	6 876	5 876	9 00	20 03
		Foot	Amount	137,600 00	192,000 00	184,000 00	110,016 00	110,016 00	144,000 00	320,480 00
12	Excavation, 79,700 Cu. Yds.	Cubic Yard	Unit Price	77	1 10	1 10	1 20	1 175	1 09	4 05
		Yard	Amount	61,369 00	87,670 00	87,670 00	95,640 00	93,647 50	86,873 00	322,785 00
13	Plain Concrete in Piers and Culverts, 455 Cu. Yds.	Cubic Yard	Unit Price	12 00	10 00	10 00	8 40	8 40	11 00	25 00
		Yard	Amount	5,460 00	4,550 00	4,550 00	3,822 00	3,822 00	5,005 00	11,375 00
14	Rubble Concrete, 1,000 Cu. Yds.	Cubic Yard	Unit Price	10 00	6 00	6 00	7 20	7 20	7 50	21 00
		Yard	Amount	10,000 00	6,000 00	6,000 00	7,200 00	7,200 00	7,500 00	21,000 00
Total.				\$ 1,133,149 00	\$ 1,047,120 00	\$ 1,039,120 00	\$ 797,559 60	\$ 794,105 50	\$ 882,828 00	\$ 1,579,570 00
Grand Total.				\$ 2,995,965 70	\$ 2,876,570 50	\$ 2,809,648 05	\$ 2,294,201 64	\$ 2,357,828 00	\$ 4,257,558 43	\$ 1,956,578 00
Extra Work.				+15%	+10%	+10%	+10%	+15%	+15%	

In addition to bids shown in the table, bids were received on single sections of Section 1: as follows:

	A. Bent	Mahoney Bros
Item 1.—Per Lin. Ft.	\$ 24 90	\$32 00
Item 2.—Per Lin. Ft.	7 06	12 00
Item 3.—Per Cu. Yd.	841	70
Item 4.—Per Cu. Yd.	11 50	20 00
Total.	\$601 135	\$779 375
Extra Work.	+5%	+15%

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The Revolution in Road Building Methods Now in Progress and the Place of John Fitzgerald in Highway History.

In the early part of the nineteenth century (about 1816), John Macadam introduced a type of road building in Great Britain that effected a revolution in highway construction.

A century later (1900), John Fitzgerald, of California, invented a method of asphaltic oil road building and a rolling tamper, which seems destined to give his name an historic interest not less than that of John Macadam.

In all probability it would have been several years more before Fitzgerald's name would have become generally known, had it not been for the advent of the automobile; for, while Fitzgerald had invented an economic and effective type of road, it remained for the automobile to cause such widespread destruction of macadam roads that engineers were forced to investigate every method of road building which promised relief from the damage caused by fast moving pneumatic tires.

Even as it is, there are hundreds of engineers who have failed to appreciate the importance of the experience that has been gained in California in oiled road construction. Perhaps the name "oiled road" is itself accountable for the failure to appreciate that the later California roads are of a permanent and substantial type. Eastern engineers do not usually know that California crude oil frequently contains as much as 75 per cent asphaltum. Hence they do not realize that the California "oiled roads" are really California asphalt roads. In no other way can we account for the failure of Eastern highway engineers to visit California with a view to studying what has been accomplished in the home of the bituminous road.

When the writer was in Los Angeles less than three years ago, he was amazed to find what had been accomplished in the scientific use of asphaltic oil as a road builder. He had expected to find mostly surface sprinkling with oil, and, instead of that, he found that substantial pavements 6 ins. thick were being made with oil and soil tamped together, not in short stretches but on a large scale of operations.

The writer also found that, in several cities, a form of asphaltic macadam was being built by this tamping process, simply by mixing broken stone with the top layer of soil and asphaltic oil and then compacting the mass with a Fitzgerald rolling tamper.

Fitzgerald told the writer that he was led to invent the rolling tamper by seeing the effect that a flock of sheep produced upon a road that he was building. He had just plowed the road, and was about to crown it up with a road machine when a flock of about 10,000 sheep came along. The feet of the first sheep sank deep into

the plowed soil, but the feet of the last sheep walked upon the surface of the soil which had been beaten into a mass as hard as brick by the feet of the sheep ahead. Fitzgerald said: "You can well believe I was the maddest man in Kern county when I had to break up that crust and found that even a pick pointed plow would scarcely feaze it."

He remarked to his partner that, if the sheep had waited only a few hours, until the road had been properly crowned, he would have paid good money to have had them walk over the road and compact it.

"A thought then struck me," said Fitzgerald. "I couldn't afford to hire a flock of sheep. Why not invent a flock?"

And he did, for his rolling tamper is a mechanical flock of sheep.

The Fitzgerald rolling tamper is first mentioned in a technical article on road building in the Yearbook of the Department of Agriculture for 1902, where its work is briefly described. In the same year its work is quite fully outlined in the December issue of "California Municipalities," a monthly magazine now known as "Pacific Municipalities."

We quote:

"It operates very similarly to a band of sheep driven over the street. By its use we made a perfect street (at Bakersfield, Calif.) right in the coldest weather where the oil was frozen almost the minute it struck the ground."

This last sentence is significant, for Eastern engineers after laboring under the false impression that all California is like Southern California, namely free from frost, whereas Fitzgerald did his first work in a mountainous section that is subject to very cold weather in the winter.

The Fitzgerald process, which has since become known as the petrolithic road or pavement, has spread rapidly throughout California and into nearby states, but it was not until this year that any of this work was done east of the Mississippi. The village of Rye, N. Y., whose engineer is C. E. Nightingale, has just completed nearly two miles of the Boston Post road by the petrolithic process. We intend to describe the work in a subsequent issue. Our present object, however, is to call the attention of engineers to the revolutionary character of the road work that has been in progress in California for the last eight years, and particularly to give credit to John Fitzgerald, whose name, in our opinion, is destined to rank with that of John Macadam. Indeed, these two names are likely to be closely linked in the future, for many of the latest petrolithic roads are really a combination of Macadam's ideas with those of Fitzgerald. To Macadam belongs the broken stone part of the road. To Fitzgerald belongs the application of bitumen (asphaltic oil or tar) and the compacting of the mass into a dustless pavement.

The original Fitzgerald process, which in-

volves the use of no broken stone at all, is likely to have a very extensive use on roads whose traffic is comparatively light. On roads subject to heavy travel, broken stone or gravel will doubtless be used. Hence, while new methods and devices will be used, old tools and machines, for macadam work, will not cease to have their application.

Is Construction Work Done as Well by Day Labor as by Contract?

Apropos of the question of efficiency and character of the work done by day labor forces as compared with contract work, discussed from time to time in these columns, the following bearing on the subject is extracted from a letter from Mr. J. F. Stern, Engineer of Bridges of the Chicago and Northwestern Ry. to the committee on steel bridges of the Association of Railway Superintendents of Bridges and Buildings. Mr. Stern writes:

"The question has often been raised as to whether the quality of work done by a bridge erecting crew, working under the direction of some official of the railroad company, is equal in grade to that done by the contractor. My experience has been that ordinarily it is not, and this is due to the fact that on most railroads the bridge erecting crew, unless working under a contractor, have no inspector to keep after them. It is impossible for a foreman to get the proper work out of his crew unless he can have an inspector on the job to insist on it being done. Even though the foreman desires to have the work up to the proper standard, the crew will balk and think him fault-finding, and in some cases sulk to such an extent that the work becomes more or less disorganized. With our own foremen we have our own inspectors on the job. These inspectors look after all the clerical work and keep the time. The inspectors check up the foremen in exactly the same manner that we would check up a contractor, and as a result, our work has improved to a considerable extent in the past few years and no criticism can be made regarding its quality."

In addition to the extra cost that is generally paid for day labor work, one great item of cost is inefficient and a poor class of construction work, and to some extent this is caused by a lack of inspectors on the work. Inspectors should be kept on day labor work as well as contract work, especially on bridge construction. The writer has seen a good deal of poor riveting done on day labor work on steel bridges for the lack of an inspector. Inspectors' salaries are always one of the so-called items of savings effected by advocates of the day labor system, but it is money saved at the expense of the character of the work done.

The U. S. Navy Department has sent out invitations calling for bids for supplying four flying machines.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Costs of Concrete and Reinforced Concrete Quoted From Various Sources.

In addition to the various articles on concrete construction methods and costs published in these columns during the current year the records of the editors include all similar data published elsewhere. Some of the more important of these data are given in the succeeding paragraphs, with credit to their original source. In all cases, however, the data have been rearranged from the form in which they were originally given and are more com-

Gravel 9.5 cu. ft.
Stone 11.1 cu. ft.
Water 2.21 to 2.71 cu. ft.

The mixer was a cubical box of 15 cu. ft. capacity and was given 9 revolutions for part of the work and from 15 to 18 revolutions for the remainder.

Each wall was divided into nine sections from 18 to 21 ft. long, which were concreted alternately; from 8 to 13 men could be worked tamping in one of these sections, and it required from 13 to 22 hours to complete sections containing from 140 to 240 cu. yds. The usual force was from 48 to 54 men including foreman, en-

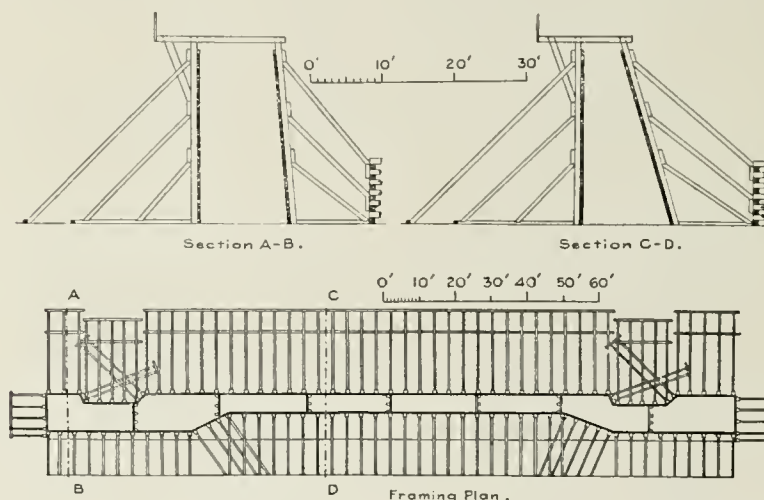


Fig. 1—Forms for Lock Wall.

pletely analyzed. The items given here have been selected for the variety of kinds of work they represent.

(1) *Cost of Concrete Lock Walls.*—The dimensions of the lock were as follows:

Length c. to c. of quoins.....145.75 ft.
Width between walls..... 27 ft.
Length of walls.....189.25 ft.
Height of walls..... 24 ft.
Width of walls at base..... 10 ft.
Width of walls at top.....5 and 10 ft.

There were 3,680 cu. yds. of concrete in the lock; the concrete consisted of a facing from 3½ to 6 ins. of 1-2 mortar and a core of 1-2-2-3 cement, sand, gravel and stone concrete. The sand, gravel and stone were kept soaking wet with a hose and were charged into the mixer in this condition. The quantities in one batch of about 1 cu. yd. were as follows:

Cement 4.7 cu. ft.
Sand 9.5 cu. ft.

ginger and carpenters. Each section as soon as completed was kept covered with canvas until hard and frequently sprinkled. The sheeting was removed after five days. The accompanying drawings, Fig. 1, show the wall form construction. The cost of the 3,680 cu. yds. of concrete in the lock was as follows:

Materials:	Total Cu. Yd.	Per
2,189 bbls. cement at \$3.36½	\$ 7,365.98	
1,100 bbls. cement at \$3.00½	3,305.50	
2,050 bbls. cement at \$2.98	6,109.00	
Total cement	\$16,780.48	\$4.55
1,676.7 cu. yds. stone at \$2.22	\$ 3,722.27	\$1.01
719 cu. yds. gravel at \$1.39	999.41	
324 cu. yds. gravel at \$1.43	463.32	
Total gravel	\$ 4,622.73	\$0.43

(1) Contributed article in "Engineering News," Jan. 9, 1908.

967.2 cu. yds. sand at		
\$1.22	\$ 1,179.98	
98 cu. yds. sand at \$1.40...	137.20	
Total sand	\$1,317.18	\$0.36
Miscellaneous	932.62	\$0.25
Total materials.....	\$24,215.28	\$6.57
Labor:		
Erecting and removing		
forms	\$ 3,536.56	\$0.96
Mixing and placing		
concrete	5,281.16	1.43
Erecting and removing		
trestle	350.00	0.10
Total	\$ 9,170.02	\$2.19
General charges:		
20% per year timber and		
and framing forms.....	\$ 1,738.65	\$0.49
25% per year materials		
for trestles	150.00	0.04
20% per year for build-		
ings	762.52	0.21
13% per year cost of		
plant	2,706.49	0.74
50% per year erecting		
mixer plant	121.56	0.03
Miscellaneous	548.27	0.15
Total	6,980.84	1.66
Grand total	\$39,466.14	\$10.72

In explanation of these figures it should be noted that the classification of the costs is only approximate, also that only a portion of cost of lumber, plant, tools, etc., is charged against the work as these materials, etc., were again used on other work. The cost of concrete materials may be further analyzed as follows:

	Cost at Railway,	Cost Hauling,	Total Cost.
2,059 bbls. cement per bbl.	\$288	\$0.485	\$3.365
900 bbls. cement per bbl.	2.52	0.485	3.005
	Cost on Barge at Site.	Cost Unloading and Storing.	
Stone per cu. yd.....	\$2.00	\$0.22	
Gravel per cu. yd.....	1.19	0.20	
Sand per cu. yd.....	1.04	0.18	

(2) *Reinforced Concrete Sewer*.—The sewer had the section shown by Fig. 2; it

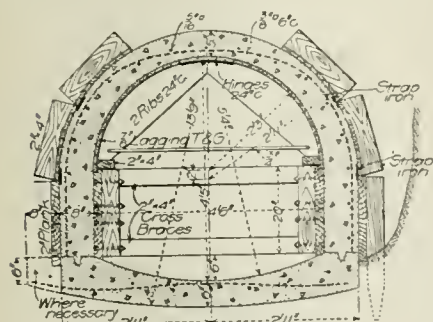


Fig. 2—Forms for Sewer.

was constructed of 1-7½ concrete mixed to a mushy consistency using the forms

(2) Wm. G. Taylor in Engineering Record, April 4, 1908.

shown by the illustration. The reinforcement was of twisted steel rods for parts of the work and of expanded metals for parts. When rod reinforcement was used it was bent on the bank and erected in cage form in the trench. The invert section was built as the first operation and the forms erected on it. The first cost of the forms shown was \$1.80 per lin. ft. of sewer and the cost of maintenance was about 12 cts. per lin. ft., including depreciation and fixed charges. Petrolene was used to grease the forms and was found superior to softsoap or to both light and dark mineral oils which were also tried. The concrete was deposited in level layers 6 ins. thick. The normal cost per lineal foot and per cubic yard of the sewer was as follows:

Mixing concrete	0.30	0.81
Placing concrete	0.27	0.73
Screeding and finishing invert.	0.08	0.22
Finishing interior surface.	0.01	0.03
Sprinkling and wetting.	0.02	0.06
Total	\$0.98	\$2.66
General charges :		
Interior forms, cons. and maint	\$0.12	\$0.32
Exterior forms, cons. and maint.	0.05	0.14
Coating oil for forms.	0.01	0.03
Cement, storage, handling and cartage	0.08	0.22
Total	\$0.26	\$0.71
Grand total	\$2.95	\$3.40

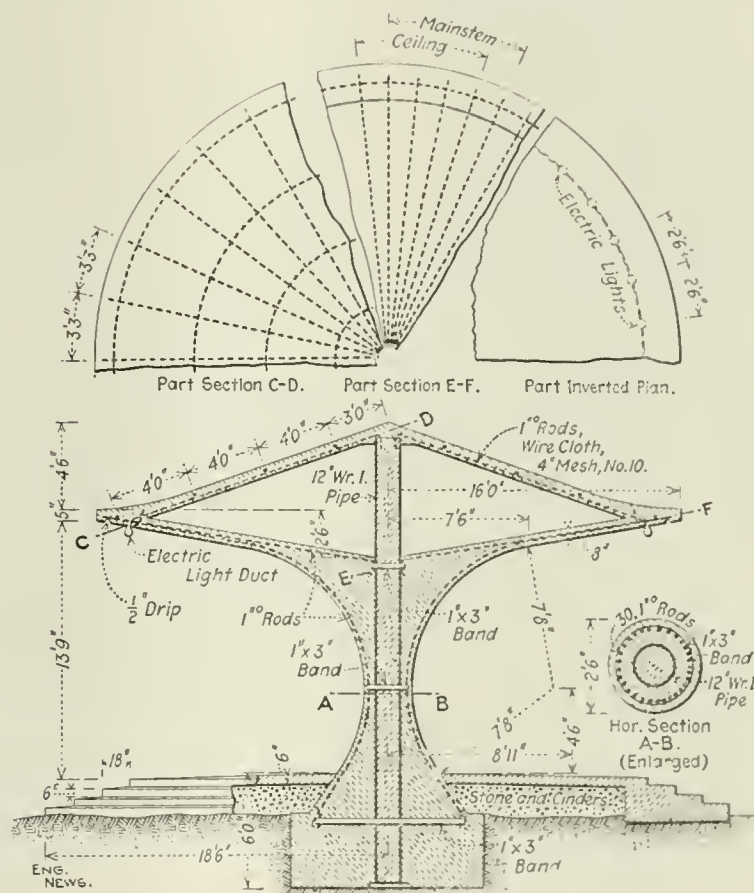


Fig. 3—Reinforced Concrete Band Stand.

	Per. Lin. Ft.	Per Cu. Yd.
Materials:		
Reinforcement (17½ lbs. per lin. ft.)	\$0.13	\$1.16
Cement (0.482 bbl. per lin. ft.) at \$1.53	0.74	2.00
Sand (0.17 cu. yd. per lin. ft.) at \$0.50	0.09	0.21
Stone (0.435 cu. yd. per lin. ft.) at \$1.10 per ton.....	0.47	1.27
Total	\$1.73	\$4.67
Labor:		
Making and placing reinforce- ment	\$0.14	\$0.38
Operation of forms.....	0.16	0.43

In reference to these figures it should be noted that as several contractors did the work these are the composite costs. They include a foreman at 50 cts., a sub-foreman at 35 cts., common labor at 17½ cts., and teams at 50 cts. per hour. No administration expenses or contractor's profit are included.

(3) *Circular Wall for Oil Tank*—The wall forms a building housing a circular steel oil tank; it is 12 ft. inside diameter, 25 ft. high and 12 ins. thick. The reinforcement consists of 78-in. twisted steel rods located 2 ins. inside the exterior face

(3) C. F. Leonard in paper read before the New England Association of Gas Engineers.

At hopper in tower.....	1
Wheeling concrete	3 to 5
Placing and spading concrete	3
Hoist engineer	1
Fireman (mixer and pump).....	1

Total 15 to 17

This gang placed on an average 150 cu. yds. of concrete per day, or about 10 cu. yds. per man. With wages averaging \$2 per man per day this would give a labor cost of 20 cts. per cu. yd. for mixing and placing, not including superintendence.

(6) *Cost of Rubble Concrete Dam.*—The dam contained 1,100 cu. yds., the main spillway portion being 22 ft. high and 17 ft. wide in the bottom with a vertical upstream face and an ogee downstream face. It contained 675 cu. yds. of 1-2½-5 broken stone concrete and 425 cu. yds. of rubble stone varying from the size of a man's head to two-man stones. The proportion of rubble stone was thus just short of 40 per cent. The rubble stones were spaced not less than 6 ins. apart. A trestle was built across-stream to hold the forms and support overhead a track for the concrete cars which were operated by hand. The concrete was machine-mixed. Labor was paid \$2.50 per day and teams \$5 per day. The prices of materials were as follows:

Cement f. o. b. railway station, per bbl.	\$3.27
Hauling cement to dam, per bbl.	0.23

Total cement	\$3.50
Sand delivered, per cu. yd.	\$1.50
Stone delivered, per cu. yd.	\$2.25

The rubble stone were taken from an adjacent hillside, the gang consisting of 1 team for hauling, per day.	\$5.00
3 men quarrying and loading, per day.	7.50
2 men unloading and placing, per day.	5.00

Total, per day	\$17.50
For the total 425 cu. yds. of rubble the cost per cubic yard was as follows:	
Quarrying, loading and hauling.	\$0.43
Unloading and placing	0.32

Total	\$0.75
The total cost of the 675 cu. yds. of concrete in the dam was as follows:	

Items.	Per cu. yd.
1.2 bbls. cement at \$3.50.	\$1.20
0.46 cu. yd. sand at \$1.50.	0.69
0.90 cu. yd. stone at \$2.25.	2.03
Mixing and placing and forms.	0.76

Total for 675 cu. yds.	\$7.68
The total cost of the dam was:	
625 cu. yds. concrete at \$7.68.	\$5,184.00
425 cu. yds. rubble at \$0.75.	314.50

1,100 cu. yds. rubble concrete at \$1.998	\$5,198.50
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(6) Samuel H. Lea in Engineering Record, May 9, 1908.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Hints on Machine Drilling and Blasting and Data on Springing Holes in Tunnel Work.*

BY GEORGE C. M'FARLANE.

Maximum economy in rock drilling and blasting depends rather on careful observance of a multiplicity of little details, than upon the selection of any particular brand or style of rock drill.

For all ordinary mining work, particularly sinking and drifting in hard rock, a No. 3, or 3¼-in. machine, of any standard make, will give good satisfaction. Among the factors which make for fast drilling and rapid driving are good strong machines, kept in first-class repair; good air, that is, air free from entrained moisture and under a pressure of 80 lbs. or 100 lbs., or even more; sharp, square-bitted steel of the smallest possible gauge; using as few flat, dry holes as possible; and arranging the work so the holes have good square starts. In all hard-rock mines, unless ventilation is extremely poor, it pays to drill small gauged holes, heavily burdened, and spring them a couple of times, so they will take a big charge of explosive.

Wherever a number of machines are used, it pays to keep a good man to look after the machine repairing and attend to extending the pipe lines, and to see they don't leak air. The machines should be taken apart, cleaned, and broken or worn parts replaced at least every two weeks; the brass rotating nut in the piston, particularly, should be renewed at the slightest sign of wear, as in hard, slippery ground, it is important that the drill is twisted uniformly. It also pays to frequently renew the chuck hushing, as with a worn chuck bashing it is impossible to chuck a drill straight, and the starter wobbles all over the face in starting a hole.

The increasing tendency to use higher air pressures for rock drilling is a very good one, and I have found it advantageous to use pressures even up to 140 lbs. At this latter pressure it is found that machines use very little more free air than at 100 lbs.

In places where only 70 or 80 lbs. of air is carried at the compressor, the pressure at the machines is very weak, especially when two or three machines on one small pipe line are started up together. In this case the machine drags the steel back and forth and wears the gauge of the steel just as much as hard, solid blows.

One of the most exasperating features of drilling hard rock is the frequent "fitting"

of the holes, caused by the steel glancing and deflecting when the hole encounters heads and slips at acute angles. When a hole fitsures before it is half way down, it is impossible to finish it, and a new hole should be started at once; however, most runners will twist and pound the chuck for an hour or so before they give a hole up. The best way to guard against fitting is to have the steel gauged small, and instead of dropping the gauge 3/16 in. per ft., shade the gauge ¼ in. or less. For 8-ft. holes, use a 2-in. starter and finish the hole 1½ in. or 1½ in., and use very long bits on the starters and seconds, the bits being made of cruciform steel only a trifle smaller than the gauge. These long bits tend to hold the hole pretty straight on the start. The long drills of the set should be of light steel and fitted with shorter bits, so the drill can weave around a little to follow the hole if it runs a little crooked. The bits should be square and the corners sharp. When starters with big wings and with the corners dubbed back are used to begin a hole, the hole will rifle more or less if the rotating mechanism of the machine is the least worn; then, as the hole goes down, the steel will be twisted with difficulty and easily sheared off by a slip.

Another advantage of using small starters and using very little drop to the gauge is, that the hole drills much faster; a 2-in. starter will drill 1 ft. in 5 min., where a 2½-in. starter would require about 7 min.; from this it follows that large bits wear their gauge faster than small bits.

A couple of years ago, in the heavy rock cuts along the line of the C. P. R. and G. T. P. R. R., in New Ontario, the deep holes in the hard granite and trap would be started with 3½-in. and 4-in. starters. Now, many of the contractors are putting down 25-ft. and 30-ft. holes and starting them with 2½-in. bits, and the drills are turning out 40% more footage than they made with the larger steel.

In the Dutton tunnel, near the Winnipeg River crossing of the Grand Trunk Pacific, the semi-circular heading, 9 ft. high and 16 ft. wide, was driven through extremely hard granite with two electric air drills. A round of 28 holes, each about 10 ft. deep, were drilled. These holes were started with a 2-in. drill and finished with a single-bitted 1-in. steel, the bit being just a shade larger than the steel. These small holes drilled very fast, an average foot of 45 ft. being turned out by each machine in a shift. One of the machines made 97 ft. in a 16-hr. shift. After the round of holes was drilled, and the machines rigged down,

*Reprinted from Mining Science.

all the holes were sprung twice, an average of 3 sticks being used for the first spring, and 6 sticks for the second spring, the 6 in.-cut holes being sprung the heaviest.

It took 4 men 3 hrs. to spring the holes twice, after which they were allowed to cool 2 hrs. before tamping in the blasting charge. Thus the springing required just about half a shift. When the holes were sprung they broke clean to bottom, and the roof and sides were left in good shape, not requiring any more scaling than was necessary before using the springing method. When drilling the small holes, the two machines would put in a round of 19-ft. holes in three shifts, each round advancing the heading 9.2 ft. On the start, before the foreman tried springing the holes, it was necessary to drill very large holes in order to get enough dynamite in the bottom of the hole to break the ground, the holes being started with a 2¾-in. bit, and finished at a depth of 9 ft. with a 1½-16-in. bit. It required 5 shifts for the machine to put in a round, and the average break was 7.4 ft. per round. This gives an idea of the economies that can be effected by springing holes where the rock is very hard. Of course, the method would hardly be applicable to softer rock, as it would probably be cheaper to drill a larger hole than to spend time and explosive chambering out a small hole. This, however, is a matter of direct calculation from actual demonstrations.

It is always good policy, when driving drifts and cross-cuts in hard ground, to drill the full round before blasting. In some localities the machine men drill and blast the in-cut first, and then rig up and drill the squaring. When this is done, they always get poor starts for the squaring holes, as a slanting face is left when the cut holes kick out, and it takes as long to get a hole started, in hard rock, on a slanting face as it does to drill the entire hole after the start is made. For the same reason, I prefer a "V" in-cut to a "draw" or "side-cut," unless there is an exceptionally good floor or slip to break to. With a side or bottom in-cut, most of the holes have to be started on a bad slant, while the "V" cut all the holes go in very nearly square with the face, and, by springing the cut holes twice, or even once, it is possible to get clean breaks every round.

The machine steel should invariably be made on the ground, as it can be made by any fairly good blacksmith for a great deal less money than the manufactured bits can be purchased for. For making machine bits, the common grades of bar and cruciform steel, costing from 7 cts. to 8 cts. a pound, is just as satisfactory as the high-grade brands of American and English tool steel, costing up to 20 cts. a pound. Every mine blacksmith has some particular fad about making or tempering drills. To handle the work to the best advantage, the blacksmith should be able to make good steel welds. Of course, it is possible to

make a bit by upsetting the steel, but it can be made in half the time by welding on a short length of cruciform steel. While it is essential that a bit should be properly tempered, it is just as important that the bit be properly made and the steel worked properly every time the bit is sharpened. The wings of the bit should be equally proportioned, rather heavy, the corners should be square, and the shoulders slope back very gradually from the cutting edge. In making the bit, care must be taken not to chisel into the core of the bit in splitting, because, when the core is deeply chisel-marked, the corners will break off in tempering. In sharpening a dull bit, most of the work should be done with a cross-peined hand-hammer; with light, quick blows of the peen of the hammer, the metal is worked from the center outward to the corners and down to the cutting edges; and many times this hand-hammering will be all the sharpening that is necessary. Every second or third dressing the bit will have to be squared up with a dolly and side-flatter and gauged with a half-round swage.

Of the many different ways of tempering machine drills, I have found the following to give the most uniform results: After the bit is sharpened, it is heated up to a bright red heat; at this heat the surface will mottle with little blisters or blebs if the drill is pulled out of the fire. At this heat, or even hotter (as the exact degree of heat does not seem to be important), the drill is shoved about an inch into the water, swished around to keep the point sizzling in fresh water, and occasionally

Dia. in.	Lgth. in	Dpth. in	No. man-holes.	Material excavated.
pipe. feet.	feet.	feet.	feet.	
8	256	7	..	Gravel
8	56	6	1	Gravel
8	290	7	..	Sand and gravel
8	234	5½	1	Gravel
10	355	7	1	Medium sand
10	478	7	1	Sand and gravel
10	734	7	3	Gravel
12	353	12	..	Gravel, small stones
12	28	8	1	Coarse gravel
15	350	8	..	Gravel
24	158	11	1	Gravel

soused to gradually cool the bit back of the cutting edge. In about 20 sec. the bit can be dropped into the tub. This method of tempering makes only the cutting edge hard, and also seems to toughen the bit. Another method which gives good results but takes more time, is to let the bit get cold from the sharpening heat, then heat to a cherry red and plunge into the tub, take out, warm it over the forge, swab it with black oil, burn the oil off and again plunge in the tub. Ordinarily, blacksmiths throw the drills into the tub, right off the anvil. Generally they are not hot enough to take a hard temper, and they are heated so far back that when they do break off, about half the bit stays in the hole.

In low altitudes, particularly on hot, muggy days, the air coming to the machines is often wet and gives a good deal of trouble by freezing up the exhaust ports and stopping the machine.

In one mine where the air was continually freezing in the machines, I found the air as it came from the compressor was so hot that you could not hold your hand on the air receiver. I partially remedied the trouble in this instance by covering the receiver with burlap and spraying it with water from a perforated pipe, which cooled the air enough to condense a considerable amount of the water thereby trapping it in the receiver.

The Cost of Excavating and Laying Pipe Sewers.

The city of Holyoke, Mass., is laying a complete system of sewers throughout the town. Some of the sewers are made of concrete blocks. The cost of excavating and back filling the trenches for these sewers was published in this journal in the issue of Sept. 16, 1908, p. 177. A large number of the pipe sewers were laid by the day labor system, under the supervision of the city engineer. In this article we give the cost of 11 examples of this work.

The forces worked 8 hrs. per day and were paid the following wages:

Foremen	\$3.50
Laborers	2.00
Teams and drivers	1.50

The cost of supplies and materials likewise of labor and hauling is given in detail in the following table:

Cost of pipe-per lin ft.	Cost of materials.	Cost of labor, etc.	Total cost.	Cost per lin. ft.
\$0.115	\$ 51.41	\$136.29	\$187.70	\$0.73
0.115	29.02	72.91	101.93	1.80
0.115	39.23	161.35	200.58	0.80
0.115	71.52	86.82	158.34	0.68
0.167	132.07	200.79	332.86	0.94
0.167	158.57	288.79	447.36	0.94
0.167	176.73	533.47	710.20	0.97
0.218	174.19	538.20	712.69	2.02
0.218	7.28	42.63	49.91	1.78
0.321	168.53	359.03	527.56	1.51
0.895	127.90	252.95	380.85	2.41

The table also shows the length of the pipe, the net cost per lin. ft. of pipe f. o. b. Holyoke, the depth of trench and the kind of material excavated. The pipe joints were made with cement. These costs do not include any engineering or superintendence, except the foremen charges.

We are indebted to Mr. James L. Tighe, city engineer of Holyoke for the above information.

The operation of the State Railways of Austria in 1906 resulted in a deficit of \$16,849,000.

Since 1890 Massachusetts has spent \$7,000,000 for grade crossing elimination.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Dust Preventives: Oils, With Methods of Analysis and Suggested Specifications for Their Use.

In our issue of Oct. 14 we devoted some space to tars used as dust preventives. In this article the use of oils (natural bitumens) as dust preventives is similarly treated. The matter in both of these articles has been taken from a bulletin prepared by Mr. Prevost Hubbard, assistant chemist in the U. S. Office of Public Roads, and issued by that Office.

Oils as a class are fatty organic substances derived from innumerable sources. They may be most conveniently divided under these heads, as animal, vegetable and mineral. While oils of the first two classes have been used to some extent as dust preventives, mineral oils are by far the most important, and have been most generally used for this purpose.

As in the case of a tar, the value of an oil as a permanent dust preventive lies in the quality and quantity of high-binding bituminous base retained by the road surface after evaporation of the more volatile constituents. The bases present in petroleum vary from those of almost pure paraffin to almost pure asphalt, many being mixtures of the two. While the paraffin oils are of much more value than the asphalt from a commercial point of view, the opposite is true from the standpoint of their use in dust suppression. An oil wholly paraffin is of value only as a temporary binder or dust layer, while an asphalt oil, owing to the character of the base contained, ranks with coal tar as a permanent binder. Like coal tar, petroleum is a mixture of a great number of organic bodies known as hydrocarbons, together with small quantities of sulphurated, nitrogenized and oxygenated compounds. The approximate composition of crude petroleum is ordinarily determined by distillation, but a knowledge of the residuums left after distillation is of far more value from the standpoint of dust suppression.

There are seven distinct oil fields in the United States, which yield oils differing in qualities. The Appalachian, which includes the States of New York, Pennsylvania, West Virginia, southeastern Ohio, and parts of Kentucky and Tennessee, produces oils which are known as eastern oils or paraffin petroleum, and which are therefore of use only as temporary binders in dust suppression. The Ohio-Indiana field produces oils which are much like those of the Appalachian and are also classed as paraffin oils; and the same is true of the

Colorado oils. The Wyoming oils vary in character from the lighter to the heavy asphaltic oils which are found principally in California. The oils from the California field, while of the most varied character, consist mainly of more or less dense asphaltic hydrocarbons. None of the components are of the paraffin series, and, as the percentage of asphaltic residue in these oils is usually high and of a good binding character, they may be considered the best for use as permanent binders. Oils from the Texas field are of a mixed character. All of them contain some paraffin as well as a greater or less amount of asphaltic residue. Some have been used successfully as dust preventives, while others are unfit for this purpose. It is needless to say that their value lies in the relative amounts of asphaltic and paraffin base contained. The Kansas oil field, including Oklahoma, produces oils quite similar to those from the Texas field and shows a mixture of paraffin and asphaltic base. The Louisiana field also yields oils similar to the Texas. Some of the wells in the Indiana and Kentucky fields have also been successfully used. In general, however, the eastern oils are of the paraffin type and useless as permanent binders; the western oils are of asphaltic character and of great value as permanent binders, while the southern oils are of a mixed character, containing part paraffin and part asphalt bases, their value as dust preventives lying in the relative amount of asphalt base contained.

While crude oil has been used to a great extent in the west for the purpose of dust prevention, it is often customary in the east to partially distill oils containing asphaltic residues before using them in this connection. By this means many of the more valuable constituents are recovered and the residual oils produced have a much better binding quality, owing to the fact that they contain a larger percentage of asphaltic base.

Crude petroleum is an oily liquid of rather unpleasant odor, with a specific gravity ranging from 0.73 to 0.97, according to the locality from which it is derived. It varies in color from greenish brown to nearly black and often exhibits a reddish brown or orange color when viewed by transmitted light. It is also somewhat fluorescent. Sand and water are often mixed with the crude oil, but these separate and settle upon standing in the storage tanks. In order to recover various products from the crude petroleum, it is subjected to a process of refining by means of fractional distillation in a manner somewhat

similar to that employed for the refining of crude coal tar.

The most valuable products are the kerosene, or burning oils, and a method known as "cracking," which increases their yield, is very generally employed. This is accomplished at a certain stage of the distillation by modifying the fire so that only the bottom of the still is subjected to a great heat, while the top and sides, being exposed to the air, become somewhat cooled. By this means the heavy oil vapors are condensed within the still itself, and upon dropping back into the residuum, which is much hotter than their boiling point, break up into lighter oils with lower boiling points with a separation at the same time of free carbon or coke, which is deposited in the residuum. Here we have a condition somewhat similar to that encountered in the case of coal tar produced at a high temperature. As the free carbon is not a binder, it is useless in a dust preventive, and when present in large amounts is apt to produce the same bad effects in an oil as in a tar.

The residuums of the various petroleum have been used to a great extent as fluxes for softening the solid native bitumens used in the paving industries. As the character of the residues present in both the crude and refined petroleum is of the greatest importance from the standpoint of dust suppression, the results obtained from a study of these fluxes should be of service in determining the suitability of various oils for this purpose. The character of the residue will naturally vary as the crude petroleum vary, although, as has been shown, the method of preparation may produce considerable effect upon the residue.

The paraffin petroleum residuums are of a soft, greasy character, and, as their name implies, contain a large amount of paraffin hydrocarbons and paraffin scale or crude paraffin. A road surface treated with material of this character will be dustless for the time being, but in damp, rainy weather will become covered with a slimy, greasy mud, which is easily washed away and leaves the road in as bad, if not worse, condition than it was before treatment. When the crude or even the residual oil is used solely as a binder, it may therefore be predicted that the outcome will prove a failure.

The base held by the California petroleum is composed of bitumens resembling asphalt. The residuum contains no paraffin and, if cracking has not been employed in its preparation, carries but little free carbon. The specifications for California fluxes call for not over 6 per cent fixed carbon. Both the crude oil and the residuums, if properly prepared, act as excellent binders and have, as a rule, given the best results of any oils which have been used as dust preventives.

The semi-asphaltic oils, such as those obtained from Texas, carry an asphaltic base, but also a considerable amount of paraffin

hydrocarbons and a little over 1 per cent of paraffin scale. While somewhat inferior to the California products, good results have often been obtained from their use on roads in both the crude and the refined state. Those which contain the greatest amount of heavy binding bitumens and the least amount of paraffin scale are, of course, to be preferred. In order to obtain the best results the residuums, as well as the crude oils of asphaltic or semi-asphaltic character, should be comparatively free from water.

Sometimes the residues from the distillation of petroleum while yet hot are subjected to the action of a jet of air, which has a tendency to thicken or harden them. It is doubtful, however, if an oil thus treated will be improved for use as a dust preventive, as the life of the oil is apt to be destroyed and its lasting qualities as a binder lessened.

The use of a paraffin petroleum is just as much to be avoided as a high-temperature tar, and in both cases a good crude product is to be preferred to a badly cracked residuum or one produced from a poor quality of crude material. Considerably more attention has been paid to the actual quality of oils which have been employed as dust preventives than to tars, although the latter have perhaps been more extensively used. A number of specially prepared or refined oil products are now on the market for use on roads, both in the form of residuums and emulsions. The residuum products have been prepared from asphaltic or semi-asphaltic oils by methods similar to those described, while the emulsions are usually residuums which have been treated with saponifying agents in order to make them miscible with water.

Owing to the fact that oils from a number of wells are commonly run through the same pipe lines from the wells to the storage tanks, it is often difficult to obtain two lots of oil having exactly the same properties, even when purchased from the same source. It is very important, therefore, that an examination of each lot of oil be made before attempting to use it for the purpose of dust prevention. Sometimes a partial chemical analysis is necessary, but in the majority of cases a few simple tests will determine its suitability for this purpose. It is also a wise measure to examine residuums even when they are especially advertised as road preparations, for, as has been stated, there is a strong tendency among refiners to crack their oils in order to increase the yield of illuminants, and when this is done the value of the residuum for the purpose of dust prevention will be considerably lessened. If the road engineer understands thoroughly the properties possessed by the oil which he is handling, he will be able to avoid many dismal failures which might otherwise occur.

Some of the results obtained from an examination of various crude and refined petroleum products in the New York Testing Lab-

oratory are given in the following tables in order to show the difference in properties possessed by the different kinds of material. They do not in any sense represent absolute values for the different classes of oils but will serve to give a general idea of the relative characteristics of each.

TABLE I—RESULTS OF TESTS OF CRUDE PETROLEUM.

Kind of oil.	Specific gravity.	Flash-ing point. °C.	Volatility at 110°C., 7 hours. Per cent.	Volatility at 160°C., 7 hours. Per cent.	Volatility at 205°C., 7 hours. Per cent.	Residue. Per cent.
Pennsylvania paraffin	0.801	(a)	17.3	58.0	68.0	632.0
Texas, semi-asphaltic	.904	43	20.0	27.0	49.0	e51.0
California, asphaltic.....	.939	26	....	...	d42.7	e57.3

a Ordinary temperature. b Soft. c Quick flow. d Volatility at 200°, 7 hours. e Soft maltha; sticky.

It will be noticed from the foregoing results that in the samples examined the specific gravity increases from the paraffin to the asphaltic oil. This is also true of the percentage of residue, while the volatility decreases correspondingly. The residues range in character from soft and probably greasy through an intermediate and but slightly viscous stage to the more or less liquid maltha of good adhesive properties. A rough idea of the character of these bases may be formed by rubbing a little of the residue or even of the crude oil between the finger and thumb. Those of a paraffin nature will feel greasy, while those of an asphaltic character will often exhibit an adhesiveness which is easily distinguishable. The color and odor will also indicate the character of the crude material to those familiar with the different varieties. In comparing the Pennsylvania with the Texas oil, it will be seen that the former carries a higher per cent of light oils than the latter. A comparison of the residuums obtained from refining oils similar to those described in Table I is shown in Table II:

TABLE II—RESULTS OF TESTS OF PETROLEUM RESIDUUMS.

Kind of oil.	Specific gravity.	Flash-ing point. °C.	Volatility at 200°C., 7 hours. Per cent.	Residue. Per cent.	Solid paraffin. Per cent.	Fixed carbon. Per cent.
Pennsylvania, paraffin	0.920	186	14.2	a85.8	11.0	3.0
Texas, semi-asphaltic	.974	214	6.2	a93.8	1.7	3.5
California, asphaltic.....	1.006	191	17.3	a82.7	0.0	6.0

a Soft.

In comparing these results an increase in specific gravities in the same direction as in the case of the crude petroleum products will be noticed. The volatility and percentage of residue, however, are not in the same order. As these are dependent entirely upon the point at which distillation is stopped in the process of refining, such a result is to be expected. The percentage of solid paraffins is found to decrease to zero as the character of the oil becomes asphaltic. Only 11 per cent was found in this particular sample from Pennsylvania, but it is not uncommon for oils of this nature to carry as high as 33 per cent paraffin. The amount of fixed carbon is found to increase with the asphaltic character of the oil, and this

fact is quite general, owing to the greater tendency of the asphaltic oils to crack during distillation.

In comparing the crude oils with the residuums it will be seen that the latter, as would naturally be supposed, carry a greater percentage of residue, and, other

things being equal, are therefore of more value as permanent binders. A considerable difference is also seen to exist between their flash points, which is the temperature at which their most volatile products flash when brought in contact with a flame. As a general rule it is not difficult to distinguish between a crude and a residual oil, but in cases where any doubt may exist the flash point is a fairly accurate indicator. Thus, in the case of the crude Texas oil and the Pennsylvania residuum, we find that their specific gravities are quite close together, and some doubt might exist as to which was crude and which residual. A determination of their flash points would at once settle this question.

THE EXAMINATION OF MINERAL OILS.

Specific Gravity.—The specific gravity of oils may be determined in the same manner as has been described for tars. If it is necessary to dilute the oil in order to obtain a reading with the hydrometer, gasoline or kerosene of known density should be used as a dilutant. A set of hydrometers ranging from 0.700 to 1.000 is usually sufficient for this purpose.

In connection with other tests, a specific-gravity determination is of value as indicating the proportion of heavy binding oils present in the material examined. It is also of value in differentiating between the various kinds of oils.

Flash Point.—The use of a special device, such as the New York State oil tester, will give the most accurate flash-point determinations, but for ordinary purposes the following method will usually serve: A beaker of about 250 c. c. capacity is half filled with the oil to be tested and gradually heated by means of a low-flame Bunsen or other suitable burner. From time to time the small flame from a capillary tube connected to the gas supply is passed just

above the surface of the oil and the temperature at which the oil vapor flashes is noted by means of a thermometer, which should be immersed in the oil. The thermometer should not rest upon the bottom of the beaker, but should be suspended from a support placed above.

The flash point of an oil indicates its most volatile oil constituent, and in a measure serves to differentiate not only between crude and refined products, but between many varieties of each class. It also serves to point out the extent to which a refined oil has been distilled.

Viscosity.—The relative viscosity of oils at a given temperature may be determined by means of special devices known as viscosimeters. While the values obtained by viscosity determinations are purely arbitrary, they indicate the relative rate of flow, and therefore in some measure the adaptability of oils to different methods of application—i. e., cold or hot, and if hot, at what temperature.

Gasoline Test for Water and Impurities.—Oils carrying a considerable amount of water and other impurities which cannot be separated by settling may be diluted with gasoline in a graduated cylinder and allowed to stand for 24 hours, or until the water and impurities settle to the bottom. If a known volume of oil is taken, a rough determination of the impurities may be made by noting the volume of these impurities as indicated by the graduate. By means of this determination the actual amount of oil present is indicated, and deductions can be made for the impurities, which should not, however, be present to any great extent.

Volatility Test.—The volatility test may be made in either one of two ways. The first is to determine the percentage loss in a sample of known weight and surface area when subjected to a known temperature for a given length of time, the character of the residue also being noted. By the second method the percentage loss is determined when the residue has acquired certain definite properties.

If the first method is employed, 20 grams of the oil is weighed into a crystallizing dish $2\frac{1}{4}$ ins. in diameter and $1\frac{1}{4}$ ins. high and heated in a drying oven for seven hours at 400° F. Upon cooling, the percentage loss in weight is noted and the residue examined. Asphaltic residues should be smooth and if warmed sufficiently should pull out to a thread. Those containing paraffin are somewhat granular, and if much is present will not pull to a thread. They are also more or less greasy to the touch. The consistency of the residue when cold is also noted, and if sufficiently dense its penetration may be determined by means of a penetrometer. If the oil contains water and light oils it is often desirable to determine its volatility at other temperatures, such as 212° F. and 325° F. By this means an idea of the relative quantities of these materials may be obtained.

The second method has been used to some extent in the examination of California oils, and consists in heating a weighed sample in a hot-air oven at 400° F. until it is reduced to what is known as "D" grade asphalt, having a penetration of 60°.

By means of the volatility test the amount of heavy base present in an oil may be determined as well as its value as a binder. While the conditions of the test are in no sense identical with those upon the road a fair idea may be obtained as to the behavior of an oil upon the road.

Naphtha-Soluble Bitumen.—The determination of naphtha-soluble bitumen is made in the same manner as for the determination of free carbon in coal tar, except that in this case 5 to 10 grams of the oil is digested with 100 cc. 88° Baume naphtha. After the residue upon the filter has been weighed it may be ignited until all organic matter has been driven off and the inorganic matter weighed when cool. The difference between this weight and that of the first residue will give the amount of organic matter insoluble in naphtha.

This determination is of special value when applied to refined oils, as the percentage of naphtha-insoluble organic material is an indication of the amount of cracking which has taken place during the process of refining.

Total Bitumen Determination.—The determination of total bitumen may be made by treatment of the oil with carbon bisulphide in a manner similar to that described for the determination of naphtha-soluble bitumen.

By noting the difference between the naphtha-soluble and the carbon-bisulphide-soluble bitumens, an idea may be obtained of the percentage of asphaltine-like hydrocarbons which tend to harden the residue.

Determination of Paraffin.—The determination of paraffin may be made according to Richardson's modification of the method of Holde. It is a tedious and difficult determination, and is not often required for an ordinary examination of a dust preventive, as the character of the residue obtained from the volatility test will indicate whether or not too much paraffin is present.

SPECIFICATIONS FOR MINERAL OILS TO BE USED AS DUST PREVENTIVES OR ROAD PRESERVATIVES.

As oils may be used on almost any kind of road either as temporary or permanent binders, their requisite qualities will depend upon the use to which they will be put. Almost any asphaltic or semi-asphaltic oil will prove satisfactory as a temporary binder if properly applied either in the form of an emulsion or in its natural state. Specifications for the properties of permanent binders only will therefore be considered.

According to Ellery a good oil should contain at least 40 per cent of commercial "D" grade asphalt, having a penetration of 60° and no more than 3 per cent of foreign

matter and water. When employed in the construction of oiled gravelled streets at Los Angeles, Cal., the following specifications were adopted for crude oil:

The specific gravity shall not be lower than 10° (1.000) nor higher than 11° Baume (0.993).

All crude petroleum shall contain not less than 70 per cent "D" grade asphalt, California standard.

All crude petroleum shall be tested for water and sediment. Deductions for water and sediment in crude petroleum will be made in exact proportion to the percentage of such water sediment found.

In the construction of asphaltic oiled and tamper-rolled dirt roads at Santa Monica, Cal., the following characteristics were specified:

The oil shall be from 12 to 14° Baume (0.986—0.972) test at a temperature of 60° F. and contain not less than 70 per cent of pure liquid asphaltum, natural nonprocessed oil to be subject to gasoline test for water and foreign matter, and not to contain over 2 per cent of water or foreign matter.

From experiments conducted by the Office of Public Roads it would seem that only reduced or residual oils are apt to prove satisfactory as permanent binders if they are semi-asphaltic in character. The following specifications are therefore suggested for this class of oils:

1. The oil shall have a specific gravity of not less than 0.95.

2. Its flash point shall be not lower than 300° F.

3. It shall be free from water as determined by the gasoline test.

4. When heated to 400° F. in the manner previously described for seven hours its loss in weight should not be over 35 per cent. The character of the residue should be smooth and nearly solid when cold, but not so hard that it may not be easily dented with the finger, and when soft it should pull to a long, thin thread.

5. The oil shall be soluble in carbon disulphide to the extent of 98 per cent, and in 88° naphtha to at least 88 per cent.

In conclusion it may be said while specifications for dust preventives and road preservatives should prove of great service in most cases in securing proper materials they are of no value unless the proper method of applying the material to the road is employed. Local conditions will often necessitate modifications of the methods of applying the material and much will therefore depend upon the experimenter or overseer of the work.

The U. S. Reclamation Service is making investigations and surveys preliminary to constructing irrigation works on the Flathead Indian Reservation in Western Montana west of the main range of the Rocky Mountains. Preliminary investigations already completed indicate that about 130,000 acres of land on this reservation are fabulously susceptible of irrigation.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Systematizing a Contractor's Office.*

BY FRANK B. GILBRETH,†

In this paper I have endeavored to give a description of the lessons that we learned during the years of evolution of the present system in our office. Systematizing a department, an office, or a business, is accomplished by one, or both, of the two following methods: (1) By efforts of the members of the organization, (2) By efforts of professional systematizers.

For the original idea of system in our office, I desire to acknowledge my indebtedness to my friend, the late Wm. H. McElwain, the possessor of one of the master commercial minds of America. The success of his whole tremendous business was, to use the words of his own statement to me, "*Due to having his entire system in writing.*" Mr. McElwain's further advice was to carry the systematization of our business as far as possible by our own efforts before calling in the professional systematizer—that is, to use both methods suggested above in the order given. After a system has been put in writing and perfected along simple lines by the men who have built up the business, it is easy for the professional systematizer to understand instantly the methods in use at the time he undertakes his task. He can then suggest changes and improvements, which can be adopted with no shock to the business.

When experts attempt to install system for a concern that has not been systematized by its own organization, a shock is bound to occur. If it is desired to introduce expert advice before any attempt is made to systematize by the organization itself, there is no such protection against shock as to take the precaution of carrying on the old system at the same time that the new system is being installed and tried out. Keep the old system in a separate building if necessary, but keep it in operation until the new system has proved itself, by actual use, to be superior to the old. The expense of temporarily maintaining a duplicate accounting department, for example, is very little compared with the protection, speed, order, rivalry and value of actual comparison.

As a result of our own experience, we believe that the best way to systematize a contractor's business is along the lines suggested by Mr. McElwain. We believe that the fundamental laws governing systematization are clearly defined. They can be used and adapted to any line of business by the men in that business.

The procedure in systematizing by the evolution method is as follows:

(1) Have each member of the office put in writing a description of the way he actually does his work. Not at first of the ideal way that the work should be done, but of the real way, the way in daily use. If an attempt is made at first to write down the ideal way, the entire benefit of the scheme will be lost. The rules must be historical, descriptive and no nearer perfect than are the members of the organization. The rules must be in such form that they can and will be obeyed without having perfect human beings to fill each position. These written descriptions should be put in the form of rules for the next clerk below, who needs description, instructions and guidance as to the work he is eventually to do.

(2) After each member of the organization has submitted his rules describing the way he actually does each part of his work, have the entire collection typewritten. A complete copy should be handed to the head of each department for correction and improvement. The corrected copies should be then inspected by the general manager.

(3) During the various inspections of the rules, it will usually develop that some members of the organization have not been able to express their ideas well. It will also develop that some one clerk has a talent for wording rules particularly well. Select this clerk to revise and arrange in proper order the entire collection of rules. If an announcement is made at the time the rules are first written that the clerk submitting the best set of descriptive rules will be made "System Clerk," better offerings from all employees will result, and a higher standard will be secured. The system clerk should see that each rule describes the easiest way to accomplish the act that it describes. Few people realize that a simple system that can be enforced easily is much better than an ideal system that is difficult to enforce. Only simple system is good system. Have the rules expressed in the simplest, most concise manner possible.

(4) Have the revised rules typewritten again, and give a complete copy to each member of the office force. Also distribute notices of prizes that will be given to those who suggest improvements that are adopted. We have found that \$1.00 for each suggestion adopted, and three special prizes of \$2, \$3 and \$5 each for the best suggestions during the month will bring in many improvements. Clerks will use every effort to discover improvements not only for the prizes, but also for the

promotion that always rewards a clerk who can constantly suggest better ways of doing work.

Our experience proves that immediately after all of the clerks have received a complete copy of all the rules governing all other departments as well as their own all hands will discover and suggest eliminating rules requiring unnecessary labor. Suggestions for improvements will then come thick and fast. The \$6 boy will understand the work of the \$12 boy. He will consider himself lucky to fill the place of the \$12 boy above him for \$9. The \$12 boy will be able to do the work of the young man who is getting \$24 per week. It means a raise of pay and more earning power for every member of the office organization. This process will extend up to the heads of departments, who can spend their time more profitably on new work that requires judgment, leaving routine work to be handled by the clerks under them.

Too much stress cannot be laid upon the importance of receiving, rewarding and incorporating suggestions from any and all members of the organization. It encourages all clerks not only to make the best use possible of their own experience, but also to investigate what is going on in other organizations and to read magazines of "Short Cuts" in business. This reading brings the organization into sympathy with the best work of system experts and labor saving devices, and paves the way for the successful entry of the professional systematizer into the office. Such reading of short cuts and improved business methods also stimulates the interest in "Motion Study."

This "Motion Study" is an object of particular interest to us, and is put into practice by us on all of our work, both office and field. It consists of observing and noting the motions used to do any piece of work, of eliminating the unnecessary motions, determining how the work may be done with the least possible number of motions, and, finally, of reducing the necessary motions to the shortest possible distance in feet and inches.

In the office this study involves the discovery of the form, methods, etc., that will save motions of each and every clerk. In our office we make use of every device that we know of to save motions. For example:

(1) "Eye saving" devices.

(a) Different forms, especially manifold sheets, made of different colored paper, the color showing to which special destination each copy of the form is to be sent. It is obviously quicker to collect or file, say, all the blue copies than to read the destination directions on each sheet.

(b) Distinguishing numbers or initials on the lower corner of form—T. L. (tool list), U. C. R. (unit cost report), to save reading of the entire forms.

(c) On all typewritten letters a list of articles to be enclosed or sent under

*Paper read at the Third Biennial Meeting of the American Public Works Association, held at Asheville, N. C., Sept. 29 and 30, 1908.

†General Contractor, New York.

separate cover is placed at the lower left hand corner. This makes it needless of the mail clerk to read the entire letter to see what is to be enclosed.

(2) "Hand saving" devices.

(a) Printing on forms all wording that is in continual use to save pen motions.

(b) Several phrases or sentences on such forms as telephone blanks, etc., all but one of which may be crossed out when form is used.

(c) General use of self-inking rubber stamps. These save the motions of inking on a pad. The place for the thumb is cut off flat to save the motions of turning the stamp right side up, as well as to save taking the eyes off the work. It is attached to a weight that will carry it back into place when it is not in use.

(3) "Foot saving" devices.

(a) Placing all files and furniture so as to have the shortest possible distance, measured in feet and inches, for the travel of the clerk who uses them.

(b) A definite place for every piece of paper that is handled in the office both before and after it is filed.

(4) "Memory saving" devices.

(a) Each file plainly labeled.

(b) All similar files labeled in the same sequence.

(c) Daily calendar made out ahead, an automatic memory of date of events, etc.

These are only a few of the many examples that might be cited.

It is impossible to go farther into detail in this paper. In our business the written system for the office work has grown into systems for the various departments. For work in the field, the written system has evolved into a field system, a concrete system, a bricklaying system, etc.

The general benefits that are sure to come from this evolutionary form of system are:

(1) There is no general upheaval, nor the slightest shock to the business. The installation of the system has cost nothing.

(2) All members of the organization are working understandingly toward the same desired end.

(3) A corps trained on the duplicate plan system is evolved simultaneously with the system.

(4) Clerks can be instantly shifted to accommodate the business, for vacations, illness, promotions, and immediate demands of any or all departments and to sudden increase of business.

(5) From its beginning the system will be popular with the clerks. Every one of them profits by it. It reduces their labor. It fits them for constant promotion, and gives them continued opportunity to win prizes. It provides places for the advancing young man, also for the faithful routinist.

(6) Competitive spirit is always active, yet "Team work" is assured.

(7) The resulting system is exactly suited to the particular office in which it is evolved, as it is the outgrowth of that office, and its particular requirements.

(8) Growth is an integral part of the conception, and therefore the system will be elastic and adapted to great fluctuations in the amount of business in hand.

After the evolutionary system has been installed and is successful, it is time to call in the professional systematizer. There is hardly a business that is not large enough to warrant the advice of a system expert. This expert, having made system a life study, will surely be able to bring from his experience and observations behind the scenes of the inside workings of fifty offices some points that will be of great value to the fifty-first. He will find in that office an organization to appreciate his study, and on the alert to receive his suggestions. His improvements will correct and improve the growing system with no resulting check to the growth.

This is the age of System Scientific Management. Such men as Frederick W. Taylor ex-president of the American Society of Mechanical Engineers, and his co-workers have done more than install systems. They have also installed entirely new methods of operation, founded upon life-time study of the fundamental laws of management. They are now ahead of their times, but the general awakening of the industrial world is coming. Their methods, which are the only solution of the struggle between capital and labor will be generally adopted because they reduce production costs and increase wages simultaneously.

There are three obstacles which the man who undertakes to systematize his office must overcome.

The first obstacle is the fear one naturally has of being called theoretical instead of practical, of being called "a dreamer" instead of "a doer." When it is realized that that man who can manage the details of his work by putting in writing a description of the simplest and the swiftest routine is best fitted to handle large undertakings in a business-like way, all such criticism will die.

The second is, thinking that his system can ever be complete. By its very nature the system of a growing business is a growing thing. It must be constantly adapted, constantly increased, constantly improved.

The third obstacle is so called "red tape," and the fear of it. No good system is ever "red tape." In fact "red tape" is simply bad system, system that has never been tackled by all the individuals of a loyal and interested organization determined to answer the following questions:

(1) How can we simplify?

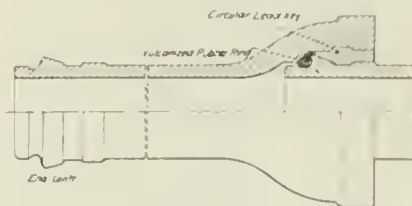
(2) How can we eliminate?

(3) How can we condense?

The whole secret of success is in a constant endeavor to answer these questions. This constant attention can be given only by the organization itself. The innovations of an expert who can, necessarily, give his whole attention to the business for a limited time only, are not to be underrated. But the best man to keep a system going and growing is the man who is vitally interested in the business and who has brought it to the point where it can successfully compete with its competitors.

A New Joint for Cast Iron Pipes.

The accompanying sketch shows a new joint construction for cast iron pipe. This construction makes an absolutely tight joint and one that at the same time gives an unusual degree of flexibility without injury to its tightness. As shown the pipe is cast with a series of circular shoulders in one of which a ring of vulcanized rubber is inserted. This rubber ring is chiefly depended upon to secure tightness. It is backed up, as will be seen, by a lead key



Joint for Cast Iron Pipes.

which is depended upon to take the shearing stresses produced by longitudinal compounds of the pressure, shocks or to any small movement of the underside. This pipe has been used successfully in France and has withstood very severe tests. It is handled by Mr. J. H. Tarpet, 1205 Fayette street, Pittsburg, Pa.

New Jersey, which heretofore has led in the trap rock production, is now second to California, according to figures issued by the U. S. Geological Survey on the Stone Industry of the United States in 1907. According to these, the total value of trap produced in California in 1907 was \$1,029,749, while the value of New Jersey's production was \$995,136. The increase in the case of California was largely due to the increased demand for crushed stone for rebuilding the roads destroyed by the earthquake in 1906.

Bids are being asked by the State Engineer and Surveyor of New York for the improvement of 287 miles of public highways.

The Federal Government at Brazil 1908 had plans drawn for about ten miles of docks for Rio Janeiro, in addition to about two miles already under contract. The cost is estimated at \$19,500,000.

Methods and Costs; Some Old; Some New.

Cost of Setting Meters.—The cost of setting meters at Cleveland, O., in 1907, was as follows, according to the annual report of the Water Works Division, Edward W. Bemis, superintendent:

	Num-ber	Average Set.	Cost.
5/8-in. meter in basement...	2,929		\$ 4.22
5/8-in. meter on sewer pipe ..	1		5.00
5/8-in. meter in brick vault...	4,368		13.47
3/4-in. meter in basement...	14		6.44
3/4-in. meter in brick vault...	9		18.01
1-in. meter in basement.....	50		7.13
1-in. meter in brick vault...	37		15.71
1 1/2-in. meter in basement...	10		7.94
1 1/2-in. meter in brick vault...	10		24.42
2-in. meter in basement ..	6		9.96
2-in. meter in brick vault...	27		21.97
3-in. meter in basement.....	3		30.71
3-in. meter in brick vault...	10		31.36
4-in. meter in basement.....	2		23.83
4-in. meter in brick vault...	8		46.78
6-in. meter in brick vault...	1		58.01

Cost of Operating and Maintaining a Meter System.—The cost of operating and maintaining the meter system of Reading, Pa., for the fiscal year ending April, 1908, was \$3,568.12, for an average of 2,012 meters in service. This is at the rate of \$1.77 per meter per year; in the preceding fiscal year the rate was \$1.75 per meter. The unit costs for the several sub-divisions of operation and maintenance are given in the annual report of Mr. Emil L. Nuebling, superintendent and engineer of water works, as follows:

Repairs	\$0.878
Clerical service	.553
Reading	.193
Delivering bills	.087
General test	.039
Sundry work	.015
Stationery, etc.....	.009

Total\$1.774

The cost of repairs increased 84 per cent over the previous year, due principally to extensive repairs to large meters. All other costs were lowered considerably.

Copper Sulphate Treatment for Removal of Anabaena.—Numerous microscopic examinations of the Antietam water supply of Reading, Pa., were made during the last fiscal year to determine the number of microscopic organisms it contained. The main object of the examinations was to find the time when the organism anabaena started to multiply, so that the water could be treated with copper sulphate, in order to remove this organism from the water and lighten the work of scraping at the Antietam filters. In his annual report Mr. Emil L. Nuebling, superintendent and engineer, describes this work as follows: Be-

tween May 4 and July 11, the average number of standard units of anabaena per cubic centimeter contained in the water supplied at the Antietam was 14, on July 18 the number had increased to 70; five days later the number was 530; on July 25 the number was 640, and the next day they had increased to 770, when the water in the lake was treated with one part of copper sulphate to 7,170,000 parts of water. On July 27, the following day, no trace of anabaena was found in the water. On Aug. 5 the water was again treated with one part of sulphate to 8,460,000 parts of water. The only anabaena discovered in the water between the time it was treated and the end of the fiscal year were 4 units on Oct. 17 and 15 units on Nov. 21. The effect of the treatment on other organisms was not as pronounced as in the case of the anabaena, belonging to the cyanophyceae, as will appear in the following table, which gives the number in standard units per cubic centimeter:

	Average number during 3 months before treatment.	Average number during 3 months after treatment.	Average number balance of fiscal year.
Diatoms	46	49	14
Chlorophyceae ...	21	86	5
Cyanophyceae ...	34	10	1
Protozoa	13	5	2
Rotifera	44	3	2

Cost of Constructing a Tunnel.—The following data abstracted from the Reclamation Record relate to the construction of the Columbar tunnel, which was constructed by contract between May 13, 1907, and April 20, 1908. The contractor was A. G. Moodhe of Portland, Ore. This tunnel forms a portion of the Main Canal of the Tieton Project, and is designed to carry 300 second-feet of water on a slope of .0045. The neat diameter of the tunnel is 7 ft., and practically all the material encountered in its construction consists of basalt intermingled with volcanic debris. There were 1,764 cu. yds. of excavation performed under the contract in the portal at an average unit cost of \$0.89 per cubic yard. Of this quantity 1,435 cu. yds. consisted of loose material in which large rock fragments occurred to such an extent as to prevent the use of plows and scrapers, and excluded all masses of rock exceeding .01 cu. yd. in volume and 329 cu. yds. of rock that could not be removed without the aid of powder including all detached masses of rock that exceeded 1/2 cu. yd. in volume. There were 1,183 lin. ft. of tunnel excavated. The plant depreciation has been estimated at 50 per cent of the original cost thereof. The United States furnished power to the contractor at \$0.04 per kilowatt hour. Owing to non-completion on time the contractor suffered a penalty of \$5 per day for 7

days. About 84 per cent of the charges for supplies was due to explosives.

	Total cost, Lin. Ft.	Cost per Lin. Ft.
Interest on investment ..\$	300	\$ 0.25
Preparatory expense	1,131	.96
Plant depreciation	2,052	1.74
Executive	500	.42
Labor	5,530	4.67
Power	1,049	.89
Penalty	35	.03
Supplies	1,257	1.06

Total contractor's cost...\$11,851 \$10.02

Cost of Reinforced Concrete Culvert.—The following data relating to the construction of a 4 ft. reinforced concrete box culvert are taken from a bulletin of the State Highway Department of Missouri. The work was done under the supervision of P. S. Quinn, County Engineer. The culvert contained 28 cu. yds. of cement and 2,500 lbs. of steel bars. The concrete was a 1-4-8 mixture. Common labor was paid 15 cts. per hour and carpenters 35 cts per hour. The cost of materials was as follows: Cement, \$1.50 per barrel delivered; sand, 65 cts per cubic yard delivered; crushed limestone, \$1.75 per cubic yard, delivered; steel, 2.3 cts per pound. The cost was as follows:

Material—	Per cu. yd.	Total.
Cement, 23 bbls.....	\$ 34.50	\$1.23
Sand, 15 cu. yds.....	9.75	.35
Crushed limestone, 28 cu. yds.	49.00	1.75
Steel, 2,500 lbs.....	57.50	2.05
Lumber, delivered	33.60	1.20
Total, material	\$184.35	\$6.58
Labor—		
Carpenter, forms, 27 hrs.\$	9.45	\$0.34
Helper, forms, 34 hrs....	5.10	.18
Steel placing, 20 hrs....	3.00	.11
Concrete, mix and place, 101 hrs.....	15.15	.54
Total, labor	\$ 32.70	\$1.17
Grand total	\$217.05	\$7.75

The cost of placing the steel was \$0.0012 per pound.

The grand total of excavation on the Isthmian Canal during the month of September was 3,158,886 cu. yds. All of this except 69,035 cu. yds. was taken from the Canal prism. This is 93,620 cu. yds. less than the record for August, and 321,384 cu. yds. less than the highest record, that of March, 1908. There were 25 working days in September, one less than in August, and one less than in March. Of the grand total of September excavation 1,374,856 cu. yds. were taken out by dredges and the remainder was dry excavation. The average rainfall for September for the territory in which excavation is in progress was 9.72 ins., as compared with 11.91 ins. in August.

Methods and Cost of Constructing a Farm Drainage System.*

The farm has an area of 476.61 acres and is shaped as shown by Fig. 1. It lies at the lowest part of a drainage basin, the only natural outlet from which is a shallow coulee, not deep enough to prevent the collection of water. The surface being comparatively level elevations taken 500 ft. apart furnished sufficient data for making plans.

Surveys and Plans.—The level work was done by one levelman and one rodman, the mode of procedure being as follows: A chain was made of a single strand of stovepipe wire 520 ft. long, or

run north, the course being kept by sighting on the flag, which had been previously set at the north property line. The stations were numbered 1, 2, etc., from north to south, and the lines A, B, etc., from east to west. Extra readings were taken at points where there was an appreciable depression or rise and their location noted with reference to the nearest station. In this manner the farm was covered with elevations approximately 500 ft. apart.

The survey also included the setting of corner posts. Where a corner was likely to be disturbed by improvements the corner was referenced in as shown by Fig. 2. The drainage system was then laid out as

structions, such as a fence or row of trees occurred close to one side, the slope of that side was made 1 on 1 and of the opposite side 1 on 2. The other physical features of the ditches were as follows:

Ditch.	Per cent grade.	Depth, feet— Max. Min. Av.	Excavation, cu. yds.
Main	0.97 & 9.91	6.91 3.21 4.65	15,110
Branch	0.07	4.77 3.84 4.15	1,914

The excavation of these ditches aggregating 17,055 cu. yds., was done by contract at 14 cts. per cu. yd. Work began June 18 and was completed on Nov. 6, 1907. On the main ditch up to the Northern Pacific Ry., 2,040 cu. yds., were removed by an elevating grader. This machine averaged 450 cu. yds. per day. On the section east of the Northern Pacific Ry., 4,000 cu. yds., removed, the machine averaging 1,000 cu. yds. per day. Sixteen horses and four men were required to operate the machine. To complete the work west of the Northern Pacific Ry., required 214 days' work for one slip scraper with an average of 43.5 cu. yds. per day. East of the Northern Pacific Ry., in finishing the work after the grader, the slip scrapers averaged 11 cu. yds. per day.

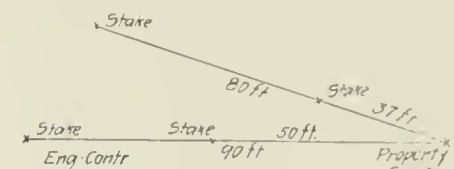


Fig. 2—Method of Referencing Property Corner.

Each slip includes the wages of 1½ men and one team, exclusive of the wages of the contractor, who acted as foreman, managing 4 to 8 teams.

A few stations were let to subcontractors. Along the road west of the farm one man and team in six days removed 60 cu. yds. per day. The same man on the branch in 10.3 days averaged 65 cu. yds. per day; however, this man and team had worked for six years on ditch construction. Another outfit of two teams and three men on the branch averaged 50 cu. yds. per team per day, for 10.5 days. The contractors' teams west of the Northern Pacific Ry., averaged 41.1 cu. yds. per day, which included the finishing of the section on which the grader had been used.

Much delay was caused by the rainy weather, which softened the earth to such an extent that the grader would not run and made the slope so slippery that difficulty was had in pulling out the slips. As there was no outlet when the work was begun, the partially finished sections could not be drained. At the time of a rain they would fill with water, which would necessitate the abandonment of the work at that point and the opening up of a new place. These incompleting sections, after standing full of water, were difficult to finish as they became so slushy in the bottom that teams could not get through. The section through the deepest cut did not dry out the entire season and it was with difficulty

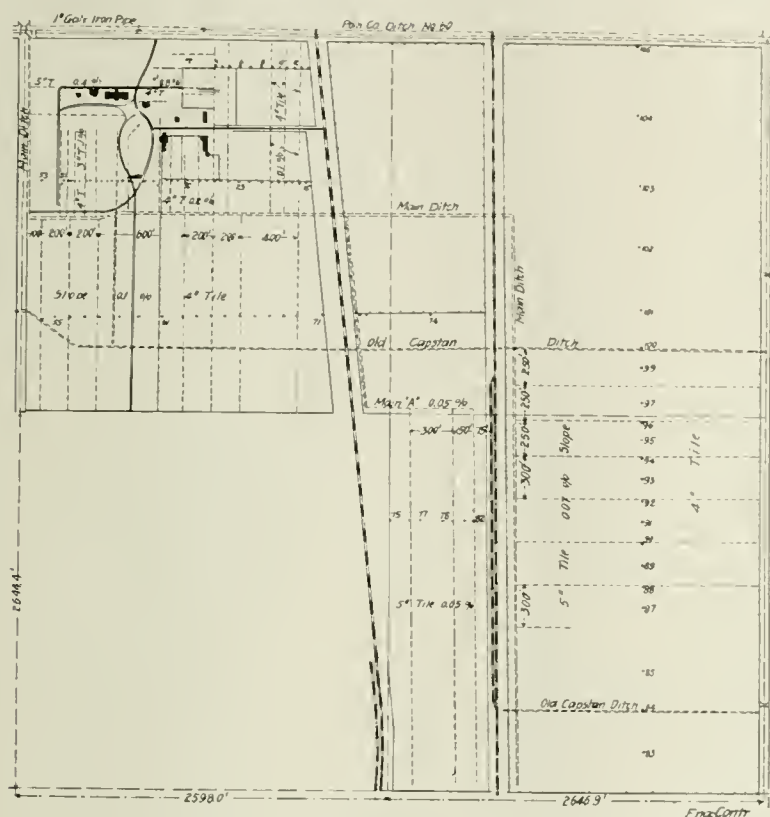


Fig. 1—Plan of Tile Drainage System for Northwest Experiment Farm.

one-tenth the distance between north and south property lines. Beginning at the northeast corner of the farm a flag was set one chain west on the north property line. A chain length was then measured south on the east property line, and the instrument set up at this point. The rodman, as he passed the levelman caught up the front end of the chain and moved ahead its length, when the turning pin was put in. Surface readings were taken at the instrument and the turning pin. On reaching the south line of the farm one chain west gave the point for starting north on the next line, while a second chain west gave the point at which to set the flag for the return line south. The rodman then dropped back to the second line which was

shown by Fig. 1. As will be seen, the main ditch had its outlet at the northwest corner of the farm into a county ditch, built along the north boundary of the farm. This county ditch was secured by organizing a drainage district in the usual manner, the farm paying merely its portion of the cost. As shown, the main ditch has one branch. The ditches designated as old capstan ditches had been built in 1903, as part of a previous attempt at drainage; they are not further considered.

OPEN DITCH SYSTEM

The open ditch system consists of the main and branch ditches mentioned above. Open ditches were specified to be 3 ft. wide on the bottom, with 1½ on 1 side slopes, but in actual construction the bottom was made of such a curve as would conform to the shape of a slip scraper, the 3 ft. width being 4 to 5 ins. above grade line. Also the side slopes were modified; where ob-

*Abstract of a Report on the Installation of an Experimental Drainage System at the Northwest Experiment Farm. University of Minnesota, Crookston, Minn. Bulletin No. 110.

that it was completed the week before the ground froze. Labor cost the contractor \$2 per day until harvest began, when it was raised to \$3.50 per day. Teams without drivers cost \$2.50 per day. The teams were idle a number of days, due to rain and scarcity of help and considerable time was spent in attempting to drain the work.

Bridges.—There were six bridges required across the farm ditch; one of these was a railway bridge, one a culvert and four were highway bridges of the general construction shown by Fig. 3.

Road Bridge No. 1.—The floor of this bridge was 16 ft. long, 8 ft. wide, and $8\frac{1}{2}$ ft. above the grade line of the ditch. Piling had to be used. The following was the cost of this bridge:

8 12"x12' cedar piling at 23c per lineal ft.	\$ 22.08
2 10"x10"x16' rough pine, caps, 267 ft. at \$31.00.	8.28
15 3"x12"x8' rough pine, stringers, 360 ft. at \$31.00.	11.16
8 3"x12"x16' rough pine, flooring, 381 ft. at \$31.00.	11.90
8 2"x12"x16' rough pine, sheeting, 256 ft. at \$32.00.	8.19
12 2"x12"x16' rough pine, wing sheeting, 384 ft. at \$32.00.	12.29
1 4"x1"x1.5' rough pine, railing posts, 24 ft. at \$31.00.	0.74
4 2"x6"x8' rough pine, side railing posts, 32 ft. at \$28.00.	0.90
2 2"x8"x8' rough pine, railing caps, 213 ft. at \$28.00.	0.60
1 8' cedar posts for wings, 25c each	1.00
8 7' cedar posts for wings, 13c each	1.04
8 0.5"x22" drift bolts, 10c each.	.80
4 0.5"x8" bolts, 5c each.	.20
20lb 60-pd. spikes, 1c.	.80
6lb 20-pd. spikes, 4c.	.24
Team and driver hauling lumber, 5 hrs. at 45c per hr.	2.25
Team and driver driving piles, 10 hrs. at 45c per hr.	4.50
Labor of driving piles, 2 men 10 hrs. each at 20c per hr.	4.00
Labor of building, 25 hrs. at 20c per hr.	5.00
Contingencies—extra wages for foreman, use of pile driver, etc.	5.00

Total\$100.97

Road Bridge No. 2.—This bridge was 18 ft. long, 7 ft. wide and 7 ft. above grade. Cedar posts, set by digging, were used in place of piles. The wings were stepped back so that the ends of the plank would reach the solid earth. The cost of this bridge was as follows:

20 8' cedar posts at 25c each.	\$ 5.00
2 3"x8"x18' rough pine, caps, 72 ft. at \$31.00.	2.16
14 3"x8"x18' rough pine, flooring, 504 ft. at \$30.	15.12
4 3"x6"x7' rough pine, braces, 42 ft. at \$28.00.	1.18

10 3"x10"x9' rough pine, stringers, 225 ft. at \$31.00.	6.97
10 2"x8"x18' rough pine, sheeting, 240 ft. at \$29.00.	6.96
25lb 60-pd. spikes at 4c.	1.00
4lb 20-pd. spikes at 4c.	.16
Man and team hauling lumber $\frac{1}{2}$ day at \$1.50 per day	2.25
Labor of building and grading, 25 hrs. at 20c	5.00
Foreman, 7 hrs. at 30c per hr.	2.10
Team grading, 3 hrs. at 25c per hr.	.75
Total	\$48.65

WINGS:

9 7' cedar posts at 13c each.	\$ 1.17
6 2"x8"x12' rough pine, sheeting, 96 ft. at \$27.00.	2.59
5 2"x8"x18' rough pine, sheeting, 120 ft. at \$29.00.	3.48
5lb 60-pd. spikes at 4c per lb.	.20
4lb 20-pd. spikes at 4c per lb.	.16
Team hauling lumber, 2 hrs. at 45c per hr.	.90

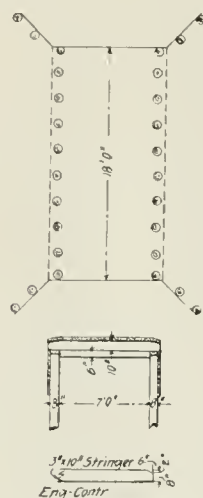


Fig. 3—Farm Road Bridge.

Labor of building and grading, 20 hrs. at 20c.	5.20
Team grading, 3 hrs. at 25c.	.75

Total	\$14.45
Grand total	\$63.10

Road Bridges Nos. 3 and 4.—These bridges were identical in construction. They were 16 ft. long and 5.7 ft. above the grade line of the ditch. They cost as follows:

18 7' cedar posts, 13c each.	\$ 2.34
4 7' cedar posts for wing, 13c each.	.52
2 3"x8"x16' rough pine, caps, 64 ft. at \$28.00.	1.79
3 3"x6"x7' rough pine, braces, 31.5 ft. at \$28.00.	.88
9 3"x10"x9' rough pine, stringers, 202.5 ft. at \$31.00.	6.28
13 3"x8"x16' rough pine, flooring, 416 ft. at \$28.00.	11.65
16 2"x8"x16' rough pine, sheeting, 311 ft. at \$27.00.	9.20
5 2"x8"x16' rough pine, wing sheeting, 106.6 ft. at \$27.00.	2.88
24lb 60-pd. spikes at 4c per lb.	.96
8lb 20-pd. spikes at 4c per lb.	.32

Labor of building, 26 hrs. at 20c per hr.	5.20
2 men and team grading, 1 hrs. at 65c per hr.	2.60

Total\$14.62

Corrugated Metal Culvert.—The metal culvert was 18 ft. long and 4 ft. in diameter, the bottom being 6 ins. lower than the grade line of the ditch. Concrete solid walls were built rising from bottom of culvert to the ground surface, and extending into both banks. These walls were 20 ins. thick to top of pipe, 18 ins. thick to within 8 ins. of the surface, and the top 8 ins. was 12 ins. thick. The top 8 ins. was of 1-6 mortar and the remainder was of 1-4-4 broken tile concrete. Condensed tile was broken into 1 to 2-in. pieces. The walls were 12 ft. long at the level of the top of the pipe and 20 ft. long at the surface. The forms were constructed by first placing the plank parallel to the slopes until the concrete was carried to the top of the pipe, and up the slopes to the surface. After this had hardened for 24 hours, the planking was taken down and laid horizontal to construct the center part of the wall. This method of constructing the forms required a minimum of lumber and no cutting of the lumber. The cost of the culvert was as follows:

1 Corrugated metal pipe, 4 ins. diam. 18 ins. long, \$6 per ft.	\$108.00
Hauling culvert from depot, 2 men and team, 2 hrs. at 65c per hr	1.30
Labor, preparing ditch for culvert, 2 men 3.5 hrs. ea. at 30c.	1.40
Bolting pipe together and lowering into ditch, 3 men, 3.5 hrs. at 20c	2.10
37.5 sacks of cement at 75c per sack.	28.12
5.6 cu. yds. of sand at \$1.50 per cu. yd.	8.40
5 cu. yds. broken tile at 54c per cu. yd. for breaking	2.70
Labor of building abutment, 82 hrs. at 20c per hr.	16.40
2 men and team grading, 5 hrs. at 65c per hr.	3.25
Incidentals	3.00

Total\$175.64

Railroad Bridge.—This bridge was a pile bridge built by the railway company, and cost as follows:

1 brick 16 ft. pile bridge, at \$10.	\$160.00
135 cu. yds. excavation, at 30c.	40.50
Incidentals	23.05

Total\$223.55

TILE DITCH SYSTEM.

Tile.—Usually the average tile over-runs in length from $\frac{1}{4}$ to $\frac{1}{2}$ inch. As customarily made, the tile are not square on the end and many of them are not perfectly straight, being slightly bowed. When these irregularities are small, or do not both occur in the same pipe, they will not interfere with laying. Tile are sold at so much per thousand pieces, which are sup-

posed to lay 1,000 ft. of drain, the over-run in length balancing up the breakage and inspection. Where the pipes are subject to long shipments and hauls, they will not always hold out, but a good quality of pipe, carefully handled, under ordinary conditions will lay the required number of feet. The weight of tile varies somewhat with the amount of moisture they contain. A tile which has been out in wet weather, or lying on moist ground, will weigh more than if it had been kept dry.

Tile layers were instructed to throw out all tile which were soft, cracked or ill-shaped. A crack through the walls 2 ins. in depth at the end, or any irregularity which would decrease the cross section of the drain or prevent its making a good joint was sufficient cause for rejection. Table 1 gives the information relative to the tile used, on a basis of 1,000 pieces, as counted at the factory. Tile which were crushed or broken were thrown out at the car and are entered under the column headed "broken in shipment." All the rejected at the trench include those that were soft, ill-shaped or cracked, caused either in the kiln or hauling.

which they are to be dug. If for immediate use they should be strung along the line of the proposed trench by placing them end to end leaving four extras for every 100 ft., to cover shortage and inspection. In pasture fields where there is stock, or cultivated fields where there is liable to be a delay of some weeks before they are placed in the trench they should be unloaded in piles of 25 or 30. If they are to lie out through freezing winter, or for several months before construction, it is best to place them in piles of 100.

For hand trenching the tile can be unloaded within 2 ft. of the right side of the stake line. For machine trenching, they should be placed at least 3 ft. to the right of the stake line.

At the farm the hauling was usually done by five men and three teams with hayracks. One man passed the tile out of the car, while another remained in the field to help unload. The fields were soft and usually limited the size of the load, which varied from 1 to 3 tons in weight, 2 to 2½ tons being the ordinary load. The racks were 8x16 ft. and held 430 pieces of 5-in. or 610 pieces of 4-in. in

A Turbine Centrifugal Pump for Deep Well Pumping.

A centrifugal pump of a new type that is attracting attention among hydraulic engineers on account of its ability to operate economically against high heads in deep bored wells of small diameter is the turbine centrifugal. We illustrate herewith a pump of this type made by The American Well Works, Aurora, Ill. For certain kinds of deep well pumping the centrifugal turbine will, it is claimed, attain a higher efficiency than any other style of pump. The makers of the turbine illustrated assert, however, that conditions favorable to its use appear not to be generally understood. We quote them as follows:

"In 'Specifications for Centrifugal Fire Pumps' adopted by the National Fire Protection Association in May, 1907, the statement is made that: 'The turbine pattern of the centrifugal pump, involving diffusion vanes, is likely to prove better adapted for fire-pump service than the plain centrifugal, because of its higher efficiencies.' The manufacturers of the 'American' turbine affirm that their experience of 10 years in making all kinds of deep well pumps does not corroborate the above statement as the turbine has not as high efficiency as plain centrifugals made by them, its only advantage being in its ability to operate against high heads in small bore holes where it would be impossible to install a plain centrifugal and in mine pumping, where it will operate against high heads with the advantage of having all the machinery except the cylinders above ground.

To make conditions favorable to the installation of turbines more clearly understood, the relative efficiencies of the different types of deep well pumps may be stated as follows. The single acting cylinder, which delivers the capacity of the cylinder intermittently on the up-stroke of the piston, is least expensive to install, but delivers the smallest quantity of water. The double acting cylinder, which delivers the full capacity of the cylinder on both the down-stroke and the up-stroke, will deliver double the quantity of water raised by the single acting cylinder. This does not appear correct when one considers the greater displacement of the piston in the cylinder on the down-stroke, but since the flow is constant there is no water hammer in the casing and the double-acting cylinder can be operated at a higher speed and thus readily delivers double the quantity of water.

The turbine delivers practically the capacity of the casing less the displacement of the shaft, but turbines have not been made of a diameter less than 10 ins., and are therefore only adapted to wells of comparatively large bore. Turbines now in use have a diameter of from 10 to 15 ins., and deliver from 18,000 to 72,000 gallons of water per hour. A turbine will deliver more water from a deep well than any

TABLE I—SHOWING SIZE AND COST OF DRAINAGE TILE.

Make.	Size in inches	Freight.	Distance Factory shipped price. miles.	Weight, lbs.	Cost of distributing, 2 miles. ½ mile.	Broke Rejected in car. at trench.	No. ft. laid in trench
Mason City...	4	16.50	\$10.08	440	6000	5.7	1032
Union City...	4	21.00	7.68	360	6000	13.3	997
Hutchinson...	5	28.00	9.60	360	7500	11.0	987
Glencoe...	4	20.70	10.53	342	6500	41.6	924
Glencoe...	5	27.60	13.77	342	8500	36.0	969
Fertile...	4	20.00	2.10	23	7000	7.5	975
Fertile...	5	28.00	3.00	23	10000	14.5	1029.5
Fertile...	6	40.00	3.60	23	12000	19.4	975
Fertile...	8	60.00	5.40	23	18000	58.5	982

Hauling and Distributing Tile.—The condition of the fields in which the tile are to be distributed determines the size of the loads. Usually a much larger load can be hauled on a wagon road than in the field. For long hauls it is often economical to haul a full load to the field and there take part of it off before distributing. For the smaller size of the tile a wagon with three boxes can be used, but for the larger sizes, or where the land is dry, a strong hay rack serves the purpose better. The size of the rack or box necessary, and the weight of the load can be readily computed from a table of tile weights and sizes. A convenient method of hauling is to use two teams, the drivers helping each other to load and unload. Tile are usually packed in the car on the side, being securely wedged to prevent their shaking around and breaking. In loading on wagons they can be packed either on side or end, but in either case should be so packed that undue breakage will not be caused by jolting in driving over rough ground. Tile loaded on end are subject to greater vibration than when loaded on the side, but they often load to better advantage. They should be unloaded in the field from the outlet of the ditch up stream taking the ditches in the same order in

one tier on end. A wagon box 3 ft. wide, 3 ft. deep and 11 ft. 2 in. long held 285 5-in. or 510 4-in. in three tiers on end. While actually working, teams traveled at the rate of three miles per hour loaded, and four miles per hour unloaded. Four and five inch tile were transferred from the car to the wagon at the rate of 1,000 pieces per 60 minutes, and unloaded in the field at the rate of 100 pieces per 54 minutes. Under these conditions the cost of hauling and distributing was \$1.09 per ton when the distance hauled varied from 1¼ to 2½ miles, with the average of 2 miles, and \$0.65 per ton where the haul did not exceed ½ mile. The cost per mile includes time lost by breaks in wagon and harness loads becoming stalled and interferences at car by switch engines.

(To be continued.)*

The total production of Pennsylvania anthracite in 1907 was 76,432,421 long tons (85,604,312 short tons), of a spot value of \$163,584,056. The total production of bituminous and lignite coal was 394,759,112 short tons, of a spot value of \$451,211,812.

*The succeeding article will give in detail the methods used and cost of excavating trench, both by hand and by machine.—Editors.

other kind of pump except the air lift, but a turbine will maintain an efficiency of 50 per cent, while the efficiency of the air lift is only from 15 to 20 per cent

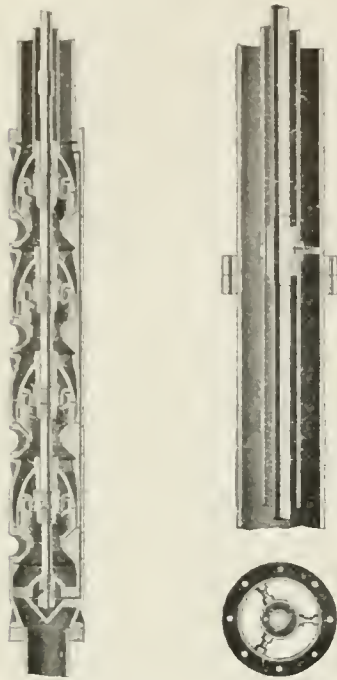


Fig. 1.

Fig. 2.

Fig. 1 is section showing impellers of four-stage turbine centrifugal. Fig. 2 is section showing method of supporting discharge pipe in shell.

The air lift, however, can be operated in a smaller bore-hole, and if desired several wells can be pumped with a single air compression plant, whereas a separate turbine is required for each well.

In explaining the greater efficiency of the plain centrifugal over the turbine in conditions in which there is not a greater lift to the intake from the surface than would be overcome by the force of gravity, and therefore adapted for the use of the centrifugal, the claim is made that a plain centrifugal, will attain an efficiency of 60 to 80 per cent, depending upon the size of the pump, which compares with the 50 per cent efficiency of the turbine. In a plain centrifugal the thrust of the shaft and friction is less, resulting in the higher efficiency. This explains why the turbine is not so well adapted for fire protection, but where water is obtained from deep wells a turbine may be used to raise the water to the surface and deliver it to a two stage centrifugal to raise it to a 100 lbs. fire protection pressure and thus obtain the most efficient pumping plant for fire protection.

Turbines are adapted for pumping water from deep wells in city water works, from mines and for factories, railroads and irrigation projects. The expense of installation is likely to exceed that of the air lift. This is due more to the additional cost of the larger bore holes required than to increased price of mechanical equipment. The greater efficiency, however, in most

cases, will recompense the additional cost in a few months' service.

In the turbine pump illustrated here, the intake of water is around a water step or balancing chamber placed immediately below the lowest turbine (Fig. 1). Any desired number of stages may be used, the largest turbines now in use being of the four-stage type. The diffusion vanes to the impeller are placed at an angle with the axis of the shaft, and rotate at a speed of about 1,700 revolutions per minute. Placed at this angle the vanes offer the least possible resistance to the water and therefore develop highest efficiency.

The turbine may be belt driven from any convenient power, but where electric power is obtainable, an electric motor can be mounted vertically on the pump head, and thus secure the most compact and economical power. When an electric motor is used, it is attached to the turbine shaft by means of a flexible coupling which equalizes any unequal alignment between the motor and the shaft, and removes all weight of the motor from the pump shaft, allowing the motor and pump shaft to rotate independent of each other.

In the superstructure (Fig. 3) of the pump at the surface, the main shaft passes through two sets of ball bearings which reduce the friction to the minimum and hold the shaft in perfect alignment. Immediately below the lower ball bearings is an oil cellar in which rotates a combined collar and impeller, which forces the oil up through a port of the upper bearing.

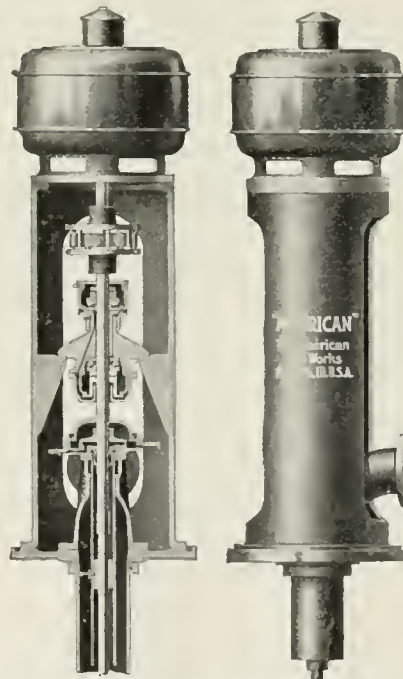


Fig. 3—Operating Head of Turbine Centrifugal Pump.

from which it flows back through the lower bearing into the cellar, thus maintaining an automatic force feed lubrication.

For installations where there is a water works system or where water pressure is

obtainable a water step or balancing chamber is placed below the ball bearings immediately above the discharge pipe. Water is admitted under pressure to the under side of the cap of this water step, in such manner as to make it ride constantly on a film of water. When the water pressure is sufficient to raise the top of the step to a greater height than is required to insure its resting on a film of water, the surplus water passes out around the cap into an overflow pipe.

Leading from a point in the discharge pipe, immediately above the highest runner, to the water step at the bottom is a water port, through which the pressure of the head in the discharge pipe is transmitted to another balancing chamber placed immediately below the lowest turbine, which also tends to overcome the downward thrust.

By this means, it is possible to entirely overcome the downward thrust of the shaft, but in practice this perfect adjustment is not usually obtained, although the thrust is very largely overcome. This, together with the perfect bearings, explains why so high efficiencies are obtained in the turbine as a deep well pump, but the greater number of bearings with the resulting greater friction show why the plain centrifugal has higher efficiency in pumping where the pump can be placed close to the water supply."

The total output of trap rock in 1907 in the United States was valued at \$4,594,103, an increase of \$857,532 over 1906. The chief gain was in crushed stone, which forms the basis of the trap rock industry and which increased in value from \$3,341,863 in 1906 to \$4,280,554 in 1907.

The joint commission of New York and New Jersey which is working on a scheme for building a bridge over the Hudson River between the two States has now taken up the question of definitely locating a site for the structure. Investigations which have been made in the last year by the engineers of the commission tend to show that the only feasible place, with regard to expense, for a bridge across the Hudson is in the neighborhood of 181st St., Manhattan. At this point it is claimed that a 1,100-span could be obtained.

The largest daily record for steam shovel excavation in the Central Division of the Isthmian Canal was made on Sept. 30, when 52 shovels took out 63,118 cu. yds. of material. The best previous record was made on July 9, when 55 shovels excavated 63,409 cu. yds. On Sept. 28, shovel 209, working at Pedro Miguel, took out 3,100 cu. yds., which is the best record for a single shovel in 1908. The best record for a single shovel was made in 1907 by shovel 226, which took out 3,750 cu. yds. on Nov. 18.

LETTERS TO THE EDITORS.

The Relative Durability of English and American Macadam Roads.

Sirs: I have read your editorial in *ENGINEERING-CONTRACTING* and the article in the "Engineering News" regarding the relative behavior of English and American macadam roads with considerable interest. I believe that the wearing qualities in the two countries are largely influenced by the difference in the class of traffic sustained. However, I feel that C. W. B. has neglected to consider, in his comparison of the macadam roads of the two countries, the comparatively mild English climate as contrasted with the alternate deep freezing and thawing which occurs in the Northern United States. Such action disintegrates the best of binders and is, in my opinion, largely responsible for the relatively rapid deterioration of our macadam roads. In this regard tarry or bituminous binders should prove effective in automatically renewing to a large extent the binding qualities during the warm summer months, besides preventing loosening and scattering of the surface materially.

Very Truly Yours,

J. G. H.

Madison, Wis., Oct. 15, 1908.

Methods of Deriving Benefits for County Drainage Systems in Indiana.

Sirs: In your issue of Oct. 7, 1908, Mr. A. O. Anderson asks for a discussion of methods used in deriving benefits for county drainage systems. I will state as best I can the method used in this county (De Kalb, Ind.) in the location and construction of public drains.

After the petition is heard and objections (if any) set aside, it is then referred to the drainage commissioners with an order to proceed on a certain day, to lay the ditch, view the lands and to make their report upon a certain day set by the court. As the laying of ditches is substantially the same in all localities, the writer will pass that part of the subject by. We will assume that all other work has been done and we are now ready to make the view to determine benefits and damages.

We first make plats (see Fig. 1) on white cardboard, of all sections of land cut by or surrounded by the shed line. We know what sections to plat, because all land supposed to be affected by the proposed drainage must be described in 40-acre lots or less, with the names of the owners, township, range, etc.

There are three commissioners, the engineers and two others. We take the plats and walk the shed line. As we pass over any description of land we trace the shed line on our plats. This, of course, is done free hand, but is a great help when office

work on the report is begun. Having walked around our drainage system and traced the shed line on the plats with the number of acres, on the inside of the shed line marked on all descriptions, cut by it (of course all descriptions inside the shed line, and not cut by it, will be taken full) we next walk up the line of the ditch that we wish to finish first (usually the main) and estimate the number of acres, in each description that will be redeemed by the ditch. This we call first benefits. At the same time we estimate the money value that this ditch will be to the land so affected. We next proceed, in the same manner, to determine the acreage of each description that can be reclaimed

size, towns and in fact all corporations and properties turning water into the ditch are assessed for its construction.

The report is next made to the court and upon being established, a superintendent of construction is appointed. He collects 10 per cent of the assessed benefits each month or enough thereof to construct the drain. The assessed benefits must always exceed the cost of construction or the ditch cannot be established.

As for the durability of cement tile, they are being used to a large extent in this locality, but their use has only been going on for two or three years which is not sufficient time to give conclusive results. However, the writer examined cement tile that stood in low ground, un-

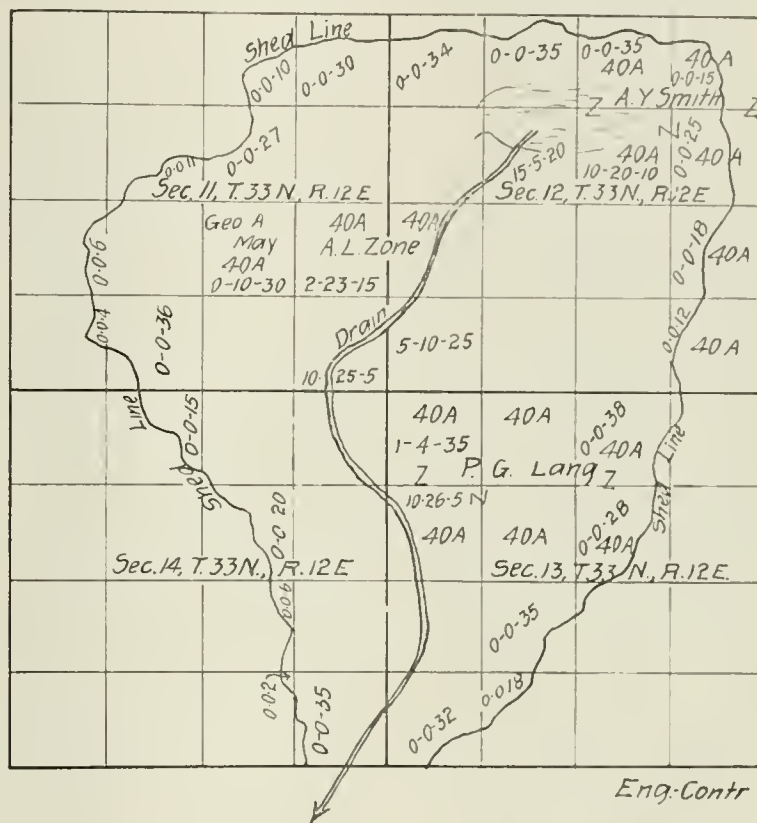


Fig. 1.

Plat shows how shed line is run and method of classifying acreage. Field plats are made on scale of 8-in. to the mile and one plat to the section.

by short side drains which depend upon the main ditch for their outlet, but which are not directly connected with it. This land we assess as second benefits. Having taken out the firsts and seconds we call all the rest shed land and assess it accordingly. You will notice that we usually make only three classes, but there are conditions which will, in justice to all concerned, require four or even more classes of benefitted land.

Under the law of Indiana a property owner is supposed to take care of the water from his lands for whatever distance it flows until it reaches a state stream. If a ditch is found to damage some property, damage is awarded it. Railroads, townships, cities of the lesser

protected during last winter, and those on the bottom of the pile showed no signs of decay, though they stood in mud and water, which was continually freezing and thawing. In the writer's opinion there is no question as to which is the better, clay or cement tile, if the cement tile is made of good material and made right. The cement tile will take more water through the shed, has greater strength and will out-weather clay tile two to one. Just the other day while on a ditch we noticed a cement pipe 10 ins. in diameter across the highway. The top of the pipe had been poorly protected and lay exposed to the wheels of vehicles. This pipe by constant wear had a hole of about 2 ins. in diameter worn through it, but did not show

the usual signs of crushing as clay tile does when exposed under like conditions.

PHILIP HOLMAN.

608 S. Main St., Auburn, Ind., Oct. 10, 1908.

A System for the Sizing and Filing of Plats.

Sirs: I am much interested in the matter of records and the filing of them. I have read the chapter on the subject in McCullough's "Engineering Work in Towns and Cities" and have followed the numerous articles in *ENGINEERING-CONTRACTING*. I offer the following as an elastic and economical system for the sizing and filing of plats. Take the standard width of 30 ins. and subdivide it by sawing the roll in two pieces of 15 ins. each. Size the length thus: Size 1, 15x22 ins. Size 2, 15x24 ins. Size 3, 15x36 ins. Size 4, 15x48 ins. Size 5, 30x24 ins. Size 6, 30x36 ins. Size 7, 30x48 ins.

Make 48 ins. the maximum length. Each drawing will be numbered serially irrespective of size or nature of the work, viz., a drawing whose serial is, say, 53,025 might be put on a 15x12 in. sheet, file it as 53,025-1 on a shelf bearing "Size 1 53,000 to 54,000" on its outer edge; if the shelf is long, subdivide it into a number of sizes. I write "shelf," a "drawer" would do as well.

Suppose the next job required say 21x40 ins. of space, use a size 7 30x48 ins. and file it as 53,026-7 on the Size 7 shelf. Suppose the next work required 40x56 ins. of space, use two Size 7 placing the 48 ins. to cover the 40 ins. required and the two 30 in. (60 in.) to cover the required 56 ins. (overlapping each 1/2 in.). The prints from these sheets might properly be pasted together but the tracings should be kept separate and filed as 53,027-7A, 53,027-7B and placed on the Size 7 shelf. Each size governs its own particular part of the filing vault, or safe.

A careful record goes without saying. A book suitably ruled would at a glance locate a needed drawing. Suppose a year or so after the last drawing 53,027-7A, 53,027-7B was made, John Dow came into the office with a print bearing 53,027-7B, and required information about the rest of it. Size 7 would be the only sizes to look over.

The tracing record book would show the tracing number, size, order number, name of the one giving the order, his order number (if any), nature of the work and date and might read thus:

53,027-7A | 2,306 | John Dow | 77 |
plat of allotment June 2, 1907. |

This could be cross indexed elsewhere of course, but the foregoing relates to sizes of drawings only and is in use in a most satisfactory manner.

Hoping the foregoing may be of use or assist in the solving of the problem, "Standardizing of Plats." I am,

A. W. SAUNDERS, C. E.

769 Highland Ave.

Johnstown, Pa., Oct. 5, 1908.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *ENGINEERING-CONTRACTING*. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0919. **Skylights.**—American Skylight and Iron Works, 215 Randolph Ave., Jersey City, N. J.

A 23-page catalog descriptive of the skylight made by this company. Drawings show how the skylights are made water tight. These skylights have been used in the U. S. Capitol building at Washington. Apparatus for opening and closing skylights of various kinds are shown.

No. 0920. **Turbine Pumps.**—Lea Equipment Co., 136 Liberty St., New York.

A 16-page catalog telling of the Lea-Degen turbine pump, and describing the tests, with the results obtained, made with this pump by Prof. Denton, of Hoboken, N. J. Anyone interested in pumping should have this pamphlet, known as Bulletin G.

No. 0921. **Four-Wheel Scrapers.**—The Maney Mfg. Co., East St. Louis, Ill.

Describes and illustrates in detail the construction and operation of a four-wheel scraper which the makers claim will move dirt 35 per cent cheaper than any other form of scraper. Comparative figures of cost of operation based on tests are given. The machine is an interesting one and earthwork contractors should get information concerning it.

No. 0922. **Ballett Hand Rock Drill.**—Thos. H. Ballett Co., Philadelphia, Pa.

This 4-page circular describes the hand rock drill being put on the market by the company named above. This drill is constructed on the same lines as this company's plug drill, but is of greater capacity, it being able to drill a 1 1/2-in. hole 48 ins. deep. The drill weighs 35 pounds. Rock men will be interested in this circular.

No. 0923. **Kno-Burn Metal Plastering Lath.**—Northwestern Expanded Metal Co., Old Colony Bldg., Chicago, Ill.

This little pamphlet contains a lot of useful information concerning metal lath and plastering. It discusses specifications for lath, method of applying lath, interior work, wall plaster, stucco, finish of walls, and gives tables of areas covered, etc., etc.

No. 0924. **Reinforced Concrete Fence Posts.**—The Luck Cement Post Co., Aurora, Ill.

Describes a model for making reinforced concrete posts and methods of molding with general discussion of the advantages of concrete posts and numerous illustrations of concrete post fences, stock and lawn fences.

No. 0925. **Dumping Trucks and Carts.**—Sunderling Mfg. Co., New York, N. Y.

The dumping trucks described and illustrated in this 12-page pamphlet embrace two special features in construction and operation. (1) The load support shifts its position so as to follow the center of gravity of the load when being dumped. This prevents a heavy blow when the tail end of the body strikes the ground. (2) The load in dumping is transferred from a point forward of the axle to a point rearwards of the axle. The several styles of trucks and one-horse carts made by the company are shown by illustrations and are briefly described.

No. 0926. **Dumping Wagons.**—The Eagle Wagon Works, Auburn, N. Y.

This pamphlet describes the bottom dumping wagon made by the firm named. The special parts and the operating mechanism are illustrated in detail and their advantageous features are pointed out. Special claims for strength are made.

No. 0927. **Water Meters.**—Pittsburg Meter Co., East Pittsburg, Pa.

This is a handsomely printed descriptive catalog of 50 pages. The utility of water meters is discussed and the "Keystone" meter is described in detail with illustrations of all important constructive portions. The descriptive text is interesting and there is the usual catalog matter regarding sizes, capacities, etc., etc., giving information likely to be wanted by purchasers. One of the specialties illustrated and described is a meter reader's book which should interest waterworks officials.

No. 0928. **Testing Machines.**—Richle Bros. Testing Machine Co., Philadelphia, Pa.

This large size 44-page book is devoted entirely to testing apparatus for cements, asphalt, stones, etc. The complete line of testing machines and appliances and testing laboratory apparatus made by this company is generally well known to engineers and this pamphlet will be of decided interest.

No. 0929. **Reinforced Concrete.**—Turner-Forman Concrete Steel Co., Philadelphia, Pa.

This company uses cold twisted medium steel bar reinforcement fabricated into unit frames before being placed in the molds. The pamphlet shows buildings constructed with details of reinforcement and quite full descriptions of the work.

No. 0930. **Rosendale Cement.**—The Consolidated Rosendale Cement Co., New York.

This pamphlet describes the character and physical properties of the natural cements made at Rosendale, N. Y., and shows a number of very handsome views of structures which have been built of this cement.

No. 0931. **Railway Signals.**—The Hall Signal Co., New York.

A 21-page pamphlet devoted to relays used in connection with the signals installed by this company. Various styles of relays are illustrated and relays for different purposes. This pamphlet is known as Circular No. 11.

No. 0932. **Metal Sheet Piling.**—The Jones & Laughlin Steel Co., Pittsburg, Pa.

A bulletin telling of a new sheet pile made up of I-beams and special rolled shape to hold together two I-beams. Either rectangular or circular coffer dams can be built with them. The many advantages of these piles, as claimed by the manufacturer are listed. It is stated that piles 16 ft. long of this style have been driven.

No. 0933. **Locomotives.**—Vulcan Iron Works, Wilkesbarre, Pa.

This company manufactures locomotives of many types and sizes from a small logging engine to a contractor's dirkey, a switching engine and the mogul and consolidation types. For each class or type they issue a leaflet giving full information as to cylinders, wheels, weight, traction force, hauling capacity, wheel base, general capacity, wheel base, dimensions, tank capacity and fuel capacity. These folders are ready printed and are mailed on request.

No. 0934. **Ventilating Fans.**—Vulcan Iron Works, Wilkesbarre, Pa.

A leaflet illustrating and telling of nine ventilators and ventilating fans manufactured by this company.

No. 0935. **Electrical Exploders.**—Star Electric Fuse Works, Wilkesbarre, Pa.

A 12-page pamphlet telling of Star exploders and batteries and showing how to use them. The directions given are illustrated by small cuts. Price lists of exploders are given in the back of the catalog.

No. 0936. **Portland Cement Machinery.**—Vulcan Iron Works, Wilkesbarre, Pa.

A 24-page catalog beautifully printed and artistically gotten up showing kilns, firing locks, smoke stacks, stone crushers, chime, coolers and other Portland cement making machinery manufactured by this company.

No. 0937. **Portable Elevators.**—New York Revolving Portable Elevator Co., 450 Princeton Ave., Jersey City, N. J.

A 24-page catalog describing this revolving portable elevator, for use in warehouses, factories, mills, storehouses, or any place where boxes, barrels or bales are to be handled. It acts as a truck in carrying things, besides being able to elevate them to such heights as the size of the machine will allow.

No. 0938. **Can and Bag Carrier.**—Wirt & Knox Mfg. Co., Philadelphia, Pa.

This can and bag carrier is being used extensively throughout the country in street cleaning, especially where the patrol system is used. Either a can or bag can be placed on the carrier, the street sweeper putting his collected sweepings into the receptacle.

No. 0939. **Electric Rock Drills.**—Northern Electric Mfg. Co., Madison, Wis.

A 28-page catalog telling of this new drill, which is said to be a radical departure from the other make of rock drills using electricity as power. The drill is said to operate without vibration when running at full speed and to be economical in power in operation. The pamphlet shows the principle on which the drill works. Other products of the company are shown.

No. 0940. **Portland Cement.**—Old Dominion Portland Cement Co., Real Estate Trust Bldg., Philadelphia, Pa.

An 8-page leaflet showing reinforced concrete chimneys and manufacturing plants built with Old Dominion Portland cement.

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Oct. 21. Akron, O.	Oct. 14
Oct. 22. Indianapolis, Ind.	Oct. 14
Oct. 22. Bateville, Ark.	Oct. 21
Oct. 23. Cincinnati, O.	Oct. 7
Oct. 24. Wilmington, O.	Oct. 7
Oct. 26. San Bernardino, Cal.	Oct. 7
Oct. 26. Cambridge, O.	Oct. 14
Oct. 26. Lynchburg, Va.	Oct. 21
Oct. 26. Wilkesbarre, Pa.	Oct. 21
Oct. 26. Franklin, Ind.	Oct. 21
Oct. 26. Auburn, Ind.	Oct. 21
Oct. 27. Portsmouth, O.	Oct. 14
Oct. 27. Mattoon, Ill.	Oct. 21
Oct. 27. Somerset, Pa.	Oct. 21
Oct. 30. Jacksonville, Fla.	Oct. 7
Oct. 31. Bryan, O.	Oct. 21
Oct. 31. Richmond, Ind.	Oct. 21
Nov. 2. Salem, Ind.	Oct. 21
Nov. 4. Vincennes, Ind.	Oct. 21
Nov. 4. Princeton, Ind.	Oct. 21
Nov. 4. Toledo, O.	Oct. 21
Nov. 4. Fargo, N. Dak.	Oct. 21
Nov. 5. Austin, Tex.	Oct. 14
Nov. 6. Tipton, Ind.	Oct. 21
Nov. 7. Frankfort, Ind.	Oct. 14
Nov. 11. Toledo, O.	Oct. 21
Nov. 11. Cleveland, O.	Oct. 21
Nov. 12. Charles City, Ia.	Oct. 21

Buildings.

Oct. 21. Mitchell, S. Dak.	Oct. 7
Oct. 21. Ann Arbor, Mich.	Oct. 7
Oct. 21. New York, N. Y.	Oct. 14
Oct. 22. Ontario, Cal.	Oct. 14
Oct. 22. Pittsburg, Pa.	Oct. 21
Oct. 22. Detroit, Mich.	Oct. 21
Oct. 23. Fort Dupont, Del.	Sept. 30
Oct. 26. New York, N. Y.	Oct. 21
Oct. 26. St. Joseph, Mo.	Oct. 21
Oct. 27. Yarmouth, N. S.	Oct. 14
Oct. 27. Keokuk, Ia.	Oct. 14
Oct. 27. Long Island City, N. Y.	Oct. 21
Oct. 28. Baltimore, Md.	Oct. 21
Oct. 28. Otisville, N. Y.	Oct. 21
Oct. 29. Cambridge, O.	Oct. 21
Oct. 30. Carthage, Mo.	Sept. 30
Oct. 30. Honolulu, Hawaii	Oct. 14
Nov. 2. Chicago, Ill.	Oct. 7
Nov. 3. Brunswick, Ga.	Oct. 14
Nov. 4. North Chicago, Ill.	Sept. 30
Nov. 4. Marietta, Ga.	Oct. 7
Nov. 5. Cleveland, O.	Sept. 30
Nov. 5. Winfield, Kan.	Oct. 7
Nov. 5. Guthrie, Okla.	Oct. 14
Nov. 5. Sacramento, Cal.	Oct. 14
Nov. 7. Eugene, Ore.	Oct. 21
Nov. 7. Weehawken, N. J.	Oct. 21
Nov. 9. St. Paul, Minn.	Oct. 7
Nov. 10. Toledo, O.	Oct. 7
Nov. 10. Schenectady, N. Y.	Oct. 14
Nov. 10. White Plains, N. Y.	Oct. 21
Nov. 11. Newbern, N. C.	Oct. 21
Nov. 16. Iola, Kan.	Oct. 21
Nov. 17. Crookston, Minn.	Oct. 14
Nov. 19. Rawlins, Wyo.	Oct. 21
Nov. 20. Trinidad, Col.	Oct. 21
Nov. 24. Baker City, Ore.	Oct. 21

Roads and Streets.

Oct. 21. Oakland, Cal.	Oct. 7
Oct. 21. Cleveland, O.	Oct. 7
Oct. 21. Brooklyn, N. Y.	Oct. 14
Oct. 21. Brooklyn, N. Y.	Oct. 14
Oct. 22. Waynesburg, Pa.	Oct. 7
Oct. 22. Pittsburg, Pa.	Oct. 7
Oct. 23. Cincinnati, O.	Sept. 30
Oct. 24. Portland, Ind.	Oct. 14

Oct. 24. Oakley, O.	Oct. 21
Oct. 24. Burlington, Ia.	Oct. 21
Oct. 21. Baltimore, Md.	Oct. 21
Oct. 24. Lexington, Ky.	Oct. 21
Oct. 26. Wilkesbarre, Pa.	Oct. 7
Oct. 26. Portland, Ind.	Oct. 21
Oct. 26. Indianapolis, Ind.	Oct. 21
Oct. 26. Kansas City, Mo.	Oct. 21
Oct. 27. Long Island City, N. Y.	Oct. 21
Oct. 27. Kansas City, Mo.	Oct. 21
Oct. 28. Ottawa, Kan.	Oct. 14
Oct. 28. Brooklyn, N. Y.	Oct. 21
Oct. 28. Springfield, O.	Oct. 21
Oct. 29. New York, N. Y.	Oct. 21
Oct. 29. Harrisburg, Pa.	Oct. 21
Oct. 31. Greencastle, Ind.	Oct. 21
Oct. 31. Cleveland, O.	Oct. 21
Oct. 31. Louisville, Ky.	Oct. 21
Nov. 2. Tipton, Ind.	Oct. 21
Nov. 2. Lebanon, Ind.	Oct. 21
Nov. 2. Jasper, Ind.	Oct. 21
Nov. 2. Newport News, Va.	Oct. 21
Nov. 2. Crown Point, Ind.	Oct. 21
Nov. 2. Columbus, Ind.	Oct. 21
Nov. 4. Monticello, Ind.	Oct. 21
Nov. 5. Frankfort, Ind.	Oct. 21
Nov. 6. Cincinnati, O.	Oct. 21
Nov. 6. Cincinnati, O.	Oct. 21
Nov. 6. Greenfield, Ind.	Oct. 21
Nov. 7. Crawfordsville, Ind.	Oct. 21
Nov. 9. Albany, N. Y.	Oct. 21

Sewers.

Oct. 21. Louisville, Ky.	Oct. 7
Oct. 22. Milwaukee, Wis.	Oct. 21
Oct. 22. Litchfield, Minn.	Oct. 21
Oct. 23. Fort Du Pont, Del.	Sept. 30
Oct. 24. Seattle, Wash.	Oct. 14
Oct. 24. De Pere, Wis.	Oct. 14
Oct. 26. Wilkesbarre, Pa.	Sept. 30
Oct. 26. Aberdeen, S. Dak.	Oct. 14
Oct. 26. Omaha, Neb.	Oct. 21
Oct. 26. Beloit, Wis.	Oct. 21
Oct. 27. Long Island City, N. Y.	Oct. 21
Oct. 28. Ite, N. Y.	Sept. 30
Oct. 28. Springfield, O.	Oct. 21
Oct. 28. Columbus, O.	Oct. 21
Oct. 29. Cleveland, O.	Oct. 21
Oct. 29. New York, N. Y.	Oct. 21
Oct. 30. Buffalo, N. Y.	Oct. 21
Nov. 2. Selma, Cal.	Oct. 7
Nov. 2. Elizabeth, N. J.	Oct. 14
Nov. 2. Washington, D. C.	Oct. 21
Nov. 4. Wyoming, O.	Oct. 14
Nov. 6. Spencer, Ia.	Oct. 21
Nov. 7. San Diego, Cal.	Oct. 21
Dec. 1. Guayaquil, Ecuador	Oct. 7

Water Supply.

Oct. 21. East Liverpool, O.	Oct. 14
Oct. 26. West Allis, Wis.	Oct. 14
Oct. 28. Verona, N. J.	Sept. 23
Oct. 28. Brooklyn, N. Y.	Oct. 21
Oct. 28. Brooklyn, N. Y.	Oct. 21
Oct. 28. Chicago, Ill.	Oct. 21
Oct. 29. Helena, Mont.	Oct. 7
Oct. 29. Richmond, Va.	Oct. 21
Oct. 29. Cincinnati, O.	Oct. 21
Oct. 30. Passaic, N. J.	Sept. 16
Nov. 2. Cohes, N. Y.	Oct. 21
Nov. 3. Mendota, Wis.	Oct. 21
Nov. 9. Kansas City, Mo.	Oct. 21
Nov. 12. Toledo, O.	Oct. 21
Nov. 16. Hartsville, O.	Oct. 21
Nov. 23. Wilmington, Del.	Oct. 21

Miscellaneous.

Oct. 21. San Francisco, Cal.	Fire Boats, Oct. 14
Oct. 21. Brooklyn, N. Y.	Fencing, Oct. 14
Oct. 24. Chicago, Ill.	Foundation Work, Oct. 7
Oct. 26. National Soldiers Home, Tenn.	Flagstaff, Oct. 7
Oct. 22. Chicago, Ill.	Underground Conduit, Oct. 14
Oct. 23. East Dennis, Mass.	Stone Jetty, Oct. 21
Oct. 24. University, Ala.	Heating System, Oct. 14
Oct. 26. Richmond, Va.	Night Soil Removal, Oct. 21
Oct. 28. New York, N. Y.	Life Boat, Oct. 14
Oct. 30. Brooklyn, N. Y.	Coal Shed, Oct. 14
Oct. 30. Rondeau, Ont.	Breakwater, Dredging, Oct. 14
Nov. 2. Washington, D. C.	Submarines, Aug. 5
Nov. 2. Detroit, Mich.	Concrete Wharf, Oct. 21
Nov. 3. Port Burwell, Ont.	Breakwater Extension, Etc., Oct. 14
Nov. 3. Wilmington, Del.	Removing Wreck, Oct. 21
Nov. 10. New York, N. Y.	Retaining Wall, Oct. 21
Nov. 14. Charleston, S. C.	Coal Handling Plant, Oct. 21
Nov. 17. Mobile, Ala.	Lock and Dam, Sept. 23

Nov. 18. California City Point, Cal.	Coal Hoisting Tower, Oct. 14
Nov. 20. Mobile, Ala.	Pump Dredge, Oct. 21

Excavation, Earth and Rock.

Oct. 21. Crookston, Minn.	Ditch Work, Sept. 30
Oct. 22. Hallowell, Minn.	Ditch, Oct. 14
Oct. 22. Langdon, N. Dak.	Drain, Oct. 21
Oct. 24. Clarksdale, Miss.	Drainage District, Oct. 21
Oct. 24. Decatur, Ind.	Ditch, Oct. 21
Oct. 24. Bluffton, Ind.	Ditch, Oct. 21
Oct. 26. Auburn, Ind.	Ditch, Oct. 21
Oct. 30. Wilmington, Del.	Dredging, Oct. 14
Oct. 30. Cerro Gordo, Ill.	The Drains, Oct. 21
Nov. 2. Glenwood, Ia.	Ditch Work, Oct. 14
Nov. 3. Vicksburg, Miss.	Levee Work, Oct. 14
Nov. 3. Greenville, Tex.	Earth Embankment, Oct. 14
Nov. 4. Prophetstown, Ill.	Ditch Work, Oct. 14
Nov. 9. Eldora, Ia.	Ditch Work, Oct. 21
N. v. 10. Velasco, Tex.	Levees, Ditches, Etc., Oct. 21
Nov. 11. Northwood, Ia.	Drainage Work, Oct. 21
Nov. 14. Galveston, Tex.	Dredging, Oct. 21
Nov. 30. Los Angeles, Cal.	Ditch Work, Oct. 21
Dec. 1. Hawaii,	Dredging, Sept. 23

Materials, Machines, Supplies, Tools, Etc.

Oct. 21. Brooklyn, N. Y.	Asphalt, Oct. 14
Oct. 21. Camden, N. J.	Meter Tube, Pump, Etc., Oct. 14
Oct. 22. Washington, D. C.	Crane, Machinery, Etc., Oct. 14
Oct. 22. Philadelphia, Pa.	Mechanical Equipment, Oct. 14
Oct. 22. New York, N. Y.	Wood Blocks, Oct. 14
Oct. 24. University, Ala.	Equipment, Oct. 11
Oct. 26. Victoria, B. C.	Water Meters, Oct. 14
Oct. 26. Washington, D. C.	Pump, Chain, Etc., Oct. 14
Oct. 26. Washington, D. C.	Engineering Supplies, Oct. 14
Oct. 26. Elmira, N. Y.	Forced Draft System, Oct. 21
Oct. 27. Washington, D. C.	Berm and Chamber Cranes, Oct. 14
Oct. 27. New York, N. Y.	Engineering Supplies, Oct. 21
Oct. 27. New York, N. Y.	Broken Stone, Oct. 21
Oct. 28. Fort Sam Houston, Tex.	Electric Elevator, Oct. 7
Oct. 28. Brooklyn, N. Y.	Well Drilling Machines, Oct. 21
Oct. 28. Baltimore, Md.	Fire Department Apparatus, Oct. 21
Oct. 29. Richmond, Va.	Electric Pumping Plant, Oct. 21
Oct. 29. New York, N. Y.	Road Oil, Oct. 21
Oct. 29. Kansas City, Mo.	Fire Hose, Oct. 21
Oct. 29. Chicago, Ill.	Lamp Posts, Oct. 21
Oct. 29. Washington, D. C.	Ornamental Gates, Oct. 21
Nov. 2. Chicago, Ill.	Generators, Pumps, Boilers, Etc., Oct. 7
Nov. 2. Los Angeles, Cal.	Water Pipe, Oct. 14
Nov. 7. Washington, D. C.	Metal Wall Lockers, Oct. 21
Nov. 9. Washington, D. C.	Tanks, Rails, Etc., Oct. 21

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Batesville, Ark. Until Oct. 22, by S. B. Wycoff, County Judge, for constructing 120 ft. long, 12 ft. roadway, steel bridge over Island Slough, near Newark. Bridge is to have concrete or stone piers.

Charles City, Ia. Until 10 a. m. Nov. 12, by H. B. Rosenkrans, County Auditor, for

constructing steel concrete bridge, 262 ft. long, over Cedar River at Main St.

Mattoon, Ill.—Until 10 a. m., Oct. 27, by Drainage Commissioners of Crabapple Creek Union Drainage District No. 1, F. M. Brooks, Clerk, at office of Volgt & Bennett, 1624 Broadway, Mattoon, for nine steel bridges, 12 ft. wide, six of which shall be 21 ft. long and three of which shall be 20 ft.

Auburn, Ind.—Until 11 a. m., Oct. 26, by E. A. Shook, County Auditor, for the construction of one pontoon bridge and for repair of another; also for steel sewer.

Princeton, Ind.—Until 11 a. m., Nov. 4, by Harry Embree, County Auditor, for construction and repair of certain bridges.

Franklin, Ind.—Until 11:30 p. m., Oct. 26, by W. B. Jennings, County Auditor, for repairing one bridge.

Richmond, Ind.—Until Oct. 31, by County Commissioners, for construction and repair of ten bridges as follows: William Waltz bridge, Dalton Township; county line bridge, between Randolph and Wayne Counties, Perry Township; Mendenhall bridge, Perry Township; Clevenger bridge, Abington Township; Bertiam bridge, Center Township; Webster bridge, Webster Township; straight line bridge, Boston Township; repairs to swinging bridge, Franklin Township; repairs to Sugar Grove bridge, Clay Township. All new bridges will be concrete.

Salem, Ind.—Until 1:30 p. m., Nov. 2, by Sam. G. Ellis, County Auditor, for constructing bridge over Carters Creek.

Tipton, Ind.—Until 2 p. m., Nov. 6, by J. F. Barlow, County Auditor, for constructing joint County bridge.

Vincennes, Ind.—Until 2 p. m., Nov. 4, by John T. Scott, County Auditor, for repairs to Antibus bridge, consisting of putting floor on 30 ft. bridge and concrete abutments.

Fargo, N. D.—Until noon, Nov. 4, by Arthur G. Lewis, County Auditor, for constructing new bridge, 40 ft. long, in Mapleton Township, new bridge 110 ft. long in Rush River Township, and repair of bridge 140 ft. long in Durbin Township.

Bryan, O.—Until Oct. 31, by Commissioners of William County, for erection of sub and superstructures of several bridges.

Cleveland, O.—Until 11 a. m., Nov. 11, by County Commissioners, Wm. F. Black, Clerk, for the construction of bridge work per Report No. 2111, retaining wall, Albion Road, Strongsville Township; Report No. 2114, concrete bridge, Hunt Road, Strongsville Township.

Toledo, O.—Until 10 a. m., Nov. 4, by County Commissioners, for constructing superstructure of a bridge over the M. & E. Canal on River Road in Waterville Township.

Toledo, O.—Until 10 a. m., Nov. 11, by County Commissioners, for constructing substructure and superstructure of bridge over Swan Creek in Adams Township.

Somerset, Pa.—Until noon, Oct. 27, by County Commissioners, R. M. Rininger, Clerk, for constructing a steel bridge; also for a stone or concrete arch.

Wilkesbarre, Pa.—Until 2 p. m., Oct. 26, by J. M. Norris, County Controller, for constructing steel and concrete bridge in Butler Township.

Lynchburg, Va.—Until noon, Oct. 26, by Council Committee on Streets, for placing new stringers under street car tracks, and laying top chords, Rivermont Viaduct. Work includes 101.5 tons channels in stringers; 6.4 tons lace bars, and 18,260 ft. B. M. of lumber. H. L. Shaner, City Engineer.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Sacramento, Cal.—Until Nov. 5, by County Supervisors, Frank Gregory, Clerk, for erection of new county jail building.

Trinidad, Colo.—Until 3 p. m., Nov. 20, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. Post Office at Trinidad, Colo.

Iola, Kan.—Until 3 p. m., Nov. 16, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. Post Office at Iola.

Baltimore, Md.—Until 11 a. m., Oct. 28, by Edward D. Preston, Inspector of Buildings, City Hall, for erection of administra-

tion building for Sydenham municipal hospital for contagious diseases.

Detroit, Mich.—Until noon, Oct. 22, by William J. Lee, Secretary, 50 Broadway, for furnishing and erecting fireproof exterior enclosed platforms and stairways at 22 school buildings.

St. Joseph, Mo.—Until 8 p. m., Oct. 26, by Board of Directors of School District, H. H. Smith, Secretary, for the installation of heating plant and sanitary appliances at the new McKinley School, Kansas Ave. Trunk & Helm, Architects, Rooms 417-18 Hughes Bldg.

Newbern, N. C.—Until 3 p. m., Nov. 11, by James Knox Taylor, Supervising Architect, Washington, D. C., for the extension, remodeling, etc., of the U. S. Post Office, Court House, and Custom House building at Newbern.

Weehawken, N. J.—Until 7 p. m., Nov. 7, by Herman Walker, 72 Hudson Ave., Guttenberg, N. J., Chairman Board of Governors, for erection of a brick hospital building on Bullserry Road for North Hudson Hospital Association. Hermann Horenburger, Architect, 422 E. 159th St., New York.

Long Island City, N. Y.—Until 11 a. m., Oct. 27, by Lawrence Gresser, President Queens Borough, President Queens Borough, 5th St. and Jackson Ave., for constructing public comfort station. Security required is \$5,000.

New York, N. Y.—Until 3:30 p. m., Oct. 26, by C. B. J. Snyder, Superintendent of School Buildings, Park Ave. and 59th St., for installing electric equipment in addition to and alterations in public school 132, on the easterly side of Wadsworth Ave. Security required is \$1,500.

Otisville, N. Y.—Until 10 a. m., Oct. 28, by Board of Health, 55th St. and 6th Ave., New York, for labor and materials necessary or required to install plumbing and heating systems in certain buildings on the grounds of the Tuberculosis Sanatorium at Otisville.

White Plains, N. Y.—Until noon, Nov. 10, by State Board of Armory Commissioners, F. A. McNeely, Secretary, Capitol, Albany, N. Y., for construction, including heating, plumbing and electrical work and gas piping for state armory at this city. F. B. Ware, State Architect, Albany, N. Y.

Cambridge, O.—Until noon, Oct. 29, by F. C. Hanna, Clerk Board of Education, for complete construction of a high school building. J. F. Orr, Architect, Central National Bank Bldg., Cambridge.

Baker City, Ore.—Until 3 p. m., Nov. 24, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (complete) of the U. S. Post Office at Baker City.

Pittsburg, Pa.—Until 10:30 a. m., Oct. 22, by Edward G. Lang, Director Public Safety, for a public comfort station in the North Side Municipal Building, corner Federal and Ohio Sts., and for remodeling toll house at north end of Smithfield St. bridge, for purposes of a public comfort house.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Burlington, Ia.—Until Oct. 24, by Dan P. Hill, County Auditor, for constructing $\frac{1}{2}$ mile of macadam and $\frac{1}{2}$ mile of Telford on Wapello Road.

Columbus, Ind.—Until 10 a. m., Nov. 2, by John M. Davis, County Auditor, for construction of 6,325 ft. of road.

Crawfordsville, Ind.—Until 10 a. m., Nov. 7, by B. B. Engle, County Auditor, for improvement of a public highway.

Crown Point, Ind.—Until noon, Nov. 2, by C. A. Johnson, County Auditor, for constructing two gravel roads.

Frankfort, Ind.—Until 2 p. m., Nov. 5, by Chas. F. Cronwell, County Auditor, for constructing six gravel roads.

Greencastle, Ind.—Until 11 a. m., Oct. 31, by D. V. Moffett, County Auditor, for the following highway work: Improvement of 11,914 ft. of macadam roadway; improvement of 1,700 ft. of roadway; improvement of 5,591 ft. of macadam roadway; improvement of 8,890 ft. of macadam roadway; improvement of 5,339 ft. of gravel roadway.

Greenfield, Ind.—Until 10 a. m., Nov. 6, by Commissioners of Hancock and Marion Counties, at Greenfield, for the construction of a gravel road on line between Marion and Hancock Counties.

Indianapolis, Ind.—Until 10 a. m., Oct. 26, by Board Public Works, for the following work: Grading and paving roadway of Hawthorne Lane; grading and paving sidewalks of Emerson Ave.; grading and paving sidewalks of Shepard St.; grading and paving

sidewalks of Sheffield Ave.; grading and paving sidewalks of Hancock St.

Jasper, Ind.—Until 1 p. m., Nov. 2, by M. A. Sweeney, County Auditor, for the construction of an extension and improvement of a public highway.

Lebanon, Ind.—Until 1 p. m., Nov. 2, by B. F. Herdrich, County Auditor, for construction of a gravel road.

Monticello, Ind.—Until noon, Nov. 4, by J. L. Ackerman, County Auditor, for constructing gravel road.

Portland, Ind.—Until 10 a. m., Oct. 26, by W. Lea Smith, County Auditor, for constructing public highway.

Tipton, Ind.—Until 10 a. m., Nov. 2, by J. F. Barlow, County Auditor, for constructing 22 gravel and macadam roads.

Lexington, Ky.—Until noon, Oct. 24, by Mayor John Skidin, for paving of South Ashland Ave. with macadam, brick, bitulithic, wooden block or asphalt.

Louisville, Ky.—Until Oct. 31, by Board Public Works, R. G. McGrath, Secretary, for constructing 31 sidewalks, of a total cost of about \$15,000.

Kansas City, Mo.—Until 3 p. m., Oct. 26, by Park Commissioners, Frank P. Gossard, Secretary, for constructing artificial stone sidewalks on east side of Broadway.

Kansas City, Mo.—Until 11 a. m., Oct. 27, by Oscar Kochler, County Surveyor, Court House, for grading and constructing necessary drains in Grand View and Mastin School House Road.

Baltimore, Md.—Until 2 p. m., Oct. 24, by John J. Watson, President Colonial Park Estates, 763 Calvert Bldg., Baltimore, for furnishing the labor and material for grading and macadamizing of about $1\frac{1}{2}$ miles of roads; for furnishing labor, use of tools, apparatus and appliances; for laying nearly 3,000 ft. of storm water drains, varying in size from 8 to 15 in., nearly 9,600 lin. ft. of cast iron water pipe, varying in size from 4 to 8 in., nearly 4,800 lin. ft. of vitrified sewer pipe, varying in size from 5 to 6 in.

Albany, N. Y.—Bids are asked by Frederick Skene, State Engineer and Surveyor, for the improvement of a considerable number of highways. Bids are to be opened at noon, Nov. 9, for the improvement of 22 highways. On Nov. 11 bids will be opened for the improvement of 21 highways, and on Nov. 13 for the improvement of 20 highways. Separate bids are asked on each highway. Official advertisement will be found elsewhere in this issue.

Brooklyn, N. Y.—Until 11 a. m., Oct. 28, by Bird S. Coler, Borough President, for nine contracts for regulating and paving with asphalt pavement. Largest contract calls for paving on Nichols Ave., the work requiring 10,930 sq. yds. asphalt pavement, including binder course and 1,520 cu. yds. concrete.

Long Island City, N. Y.—Until 11 a. m., Oct. 27, by Lawrence Gresser, President Queens Borough, 5th St. and Jackson Ave., for eight contracts for street improvement. Largest contract calls for improvement of 10th Ave., the work including 8,100 cu. yds. of earth filling (to be furnished), 1,600 lin. ft. of new bluestone curbstone, 1,900 sq. ft. of new bluestone flagstone, 1,400 sq. ft. of old bluestone flagstone to be relaid, 416 sq. ft. of new bluestone bridging, 2,400 sq. yds. of new granite block pavement, including sand joints.

New York, N. Y.—Until 11 a. m., Oct. 29, by Louis F. Haffen, President Bronx Borough, 177th St. and 3rd Ave., for ten contracts for paving. Largest contract calls for paving with asphalt blocks on a concrete foundation the roadway of Morris Park Ave. The work includes 21,140 sq. yds. of completed asphalt block pavement, and keeping the same in repair for five years from date of acceptance; 4,740 cu. yds. of concrete, including mortar bed; 1,000 lin. ft. of new curbstone, furnished and set in concrete; 8,200 lin. ft. of old curbstone, rejointed, reset on top and reset in concrete; 11,200 sq. yds. of completed asphalt block pavement, not to be kept in repair.

Cincinnati, O.—Until noon, Nov. 6, by County Commissioners, Fred Drehs, Clerk, for the following work: Under Specifications No. 711, for improvement of Rapid Run Road, from Holtzman's gate to Langloth's east line, Delhi Township; under Specifications No. 805, for repair of the Wiehe Road, from Langdon Ave. to Carthage road, Columbia Township.

Cincinnati, O.—Until noon, Nov. 6, by County Commissioners, Fred Drehs, Clerk, for improvement of Cloves and Dugan Gap Road for a distance of 12,200 ft.

Cleveland, O.—Until 11 a. m., Oct. 31, by County Commissioners, Wm. F. Black, Clerk, for grading, draining and improving of Har-

Richmond, Va., Night Soil Removal. Until
noon, Oct. 26, by E. C. Leav, Chief Health
Officer for regular monthly removal of night
soil from all dry closets in city for period
of one year.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Ornamental Gates.—Until Oct. 29, by Major J. Gray Zulinsky, Q. M., for constructing and erecting ornamental iron gates at Hampton and Salisbury National Cemeteries.

Washington, D. C.—Tanks, Rails, Etc.—Until 10:30 a. m., Nov. 9, by Capt. F. C. Boggs, General Purchasing Officer Isthmian Canal Commission, for furnishing under Circular 71, steel oil tanks, steel rail sections, rail clumps and keys, bridle bars, fish plates; repair parts for dump cars, locomotives, dredges and steam shovels; brass castings, screw plates, drill chucks, gage-glass cutters, wire and manila cable, canvas duck, mauling cases, door checks, clocks, rubber blankets, rubbing brick, sponges, starch, oxalic acid, chalk, metal polishing paste, etc.

Washington, D. C.—Metal Wall Lockers.—Until 2 p. m., Nov. 7, by Major M. Gray Zulinsky, Q. M., for furnishing, f. o. b., at place of manufacture, about 5,000 standard metal wall lockers, adopted by the Quartermaster's Department for barracks.

Chicago, Ill.—Lamp Posts.—Until 11 a. m., Oct. 29, by William Carroll, City Electrician, Room 403, 56 Fifth Ave., for furnishing the Department of Electricity with 100 more or less combination cast iron and steel electric light and lamp posts.

Baltimore, Md.—Fire Department Apparatus.—Until 11 a. m., Oct. 28, by P. W. Wilkinson, Secretary Fire Department, for furnishing two first size piston steam fire engines, and two hand hoisting devices, complete with motors and compressors.

Kansas City, Mo.—Fire Hose.—Until noon, Oct. 29, by E. Winstanley, City Purchasing Agent, for furnishing, f. o. b. cars Kansas City, 10,000 ft. 2½-in. cotton double jacket, rubber lined hose with standard "Feyh" couplings, weight 7½ pounds per set.

Brooklyn, N. Y.—Well Driving Machines.—Until 2 p. m., Oct. 28, by John H. O'Brien, Commissioner Water Supply, Gas and Electricity, 13 Park Row, New York, for furnishing and delivering well driving machinery. Security required is \$2,000.

Elmira, N. Y.—Forced Draft System.—Until noon, Oct. 26, by Henry Melville, President Board of Managers, for forced draft system for boilers at New York State Reformatory, Elmira, Franklin B. Ware, State Architect, Albany, N. Y.

New York, N. Y.—Broken Stone.—Until noon, Oct. 27, by George Cromwell, President Richmond Borough, St. George, New Brighton, for three contracts for furnishing broken stone. A total of 21,000 tons of 1½-in. and ¾-in. broken stone and screenings of trap rock or Long Island syenite is required.

New York, N. Y.—Engineering Supplies.—Until noon, Oct. 27, by George Cromwell, President Richmond Borough, St. George, New Brighton, for furnishing and delivering supplies for the Bureau of Engineering-Torjaghy. Security required is \$300.

New York, N. Y.—Road Oil.—Until 3 p. m., Oct. 29, by Park Board, Arsenal Bldg., 5th Ave. and 5th St., for furnishing and delivering Texas road oil (No. 1, 1908) for parks, Borough of the Bronx. Bids are also asked for 10,000 gallons crude petroleum oil (No. 1, 1908).

Richmond, Va.—Electric Pumping Plant.—Until 5 p. m., Oct. 29, by E. E. Davis, superintendent of Water Works, for furnishing and erecting machinery and apparatus for an electric pumping plant, including four centrifugal pumps each of 4,000,000 gallons capacity per day; four 200-h. p. electric motors, with necessary switchboard, wiring, pipes and water meters.

CONTRACTS LET.

The following contracts have been let recently:

Birmingham, Ala.—Sewers.—C. M. Burkhalter, at \$23,035, for constructing sewers.

Birmingham, Ala.—Paving.—C. M. Burkhalter, at \$1,513, for paving Florida Ave. with tar cap macadam.

Hope, Ark.—Sewers, Water Works.—Hamilton & Bros., Joplin, Mo., at \$60,000, for new sewer system; Bosh & Gray, Chicago, Ill., at \$60,000, for new water works.

San Francisco, Cal.—Building.—C. J. Lindgren Co., for the erection of the new building for the San Francisco Y. M. C. A. to cost \$500,000.

Iowa Falls, Ia.—Bridge.—Des Moines Bridge & Iron Works, Des Moines, Ia., for five-span, 100 ft. each, steel bridge to be erected over the Iowa River at this place

for the St. Paul & Des Moines R. R. Abutments and piers will be of concrete.

Blaise, Idaho—Reservoir Dam.—Harvey Holloway, for building reservoir dam on Shaker Creek for Murphy Land & Irrigation Co.

Champaign, Ill.—Bridge.—Attica Bridge Co., Attica, Ind., at \$1,180, for new steel superstructure, 78-ft. span, for bridge over Swartz Ford, in Urbana Township.

Fithian, Ill.—Bridge.—F. Burke, Newcastle, Ind., at \$3,100, for 80-ft. iron bridge with concrete abutments over Stony Creek at this place.

Murphysboro, Ill.—Bridge.—Decatur Bridge Co., Decatur, Ill., at \$1,880, for new 100-ft. steel span and 210 ft. of approaches for bridge over Big Muddy on Hamburg Road.

Normal, Ill.—Brick Paving.—Roy L. Williams, Connorsville, Ind., at \$28,588, for Fell Ave., and at \$30,558 for School and other streets. Brick will be used.

Taylorville, Ill.—Electric Railway Work.—Electrical Installation Co., 98 Jackson Blvd., Chicago, Ill., according to reports, for electrical work in connection with the construction of the street railway and overhead equipment of the plant of the Taylorville Street Railway Co.

Waukegan, Ill.—School.—Andrew Rychoman, for the construction of new parochial school for the Church of the Immaculate Conception.

Logansport, Ind.—Bridge Work.—Samuel Cotner, at \$1.35 per cu. yd., for concrete arch over Widow Creek, in Washington Township; Court Miner, at \$5.75 per cu. yd., for a 12-ft. concrete arch over Miller Creek, in Harrison Township; Samuel Cotner, at \$4 per cu. yd., for concrete bridge over Mud Branch, in Clay Township; A. F. Shuman, at \$2.25 per sq. yd., for furnishing 225 sq. yds. of bituminated paving block for reflowing Oden and Sprinkle bridges, over Deer Creek, in Jackson Township.

New Castle, Ind.—Reservoir.—Charles W. Minnick, New Castle, for constructing 700,000-gallon reservoir for this place.

Amite City, La.—Church.—Q. T. Drake, for erecting Methodist church here.

Jackson, Miss.—Water Works, Sewers.—Contracts for water works and sewer extensions have been let as follows: M. O'Herrin & Co., Pittsburg, Pa., constructing water mains, \$25,820, sewers, \$36,500; Mississippi Foundry & Machine Co., Jackson, valve boxes, manhole plates and covers, \$1,561; Rensselaer Manufacturing Co., Troy, N. Y., hydrants and gate valves, \$1,573.

Luverne, Minn.—Bridges.—P. N. Gillham, at \$2,750, for two 20-ft. span and one 24-ft. span steel bridges with cement floor and stone abutments and one 18-ft. concrete arch.

Shakopee, Minn.—Water Works.—W. C. Frazer, Rochester, Minn., at \$5,150, for material and construction of water works here.

Two Harbors, Minn.—Bridge, Grading.—Cyrille Fortier, for constructing bridge at foot of White Iron Lake, in Fall Lake Township; Joe Betzler & Son, Beaver Bay, Minn., for grading 1½ mile of road.

St. Joseph, Mo.—Brick Paving.—H. N. Rice, three contracts, for paving with brick on Edmond St., on 26th St. and on 21st St.

Helena, Mont.—Wooden Bridges.—Peter Benig, at \$2,100, for constructing two wooden bridges for county.

Lenoir, N. C.—Water and Sewer System.—Guild & Co., Chattanooga, Tenn., for installing water and sewer system for this city.

Portsmouth, N. H.—Concrete Sewer.—Small & Ingalls, Bar Harbor, Me., at \$6,716, for building concrete trunk sewer in Parrott and Richards Aves.

Kearney, N. J.—Bridge.—F. M. Stillman, 21 Exchange Pl., Jersey City, at \$313,000, for constructing bridge over Hackensack River in Kearney Township. Bridge is to consist of three fixed spans, 180 ft. e. to e., and one draw span, 248 ft., with concrete abutments on piles.

Verona, N. J.—Laying Water Mains.—Puglia & Palmer Co., Paterson, N. J., at \$15,749, for laying water mains for this borough.

Albany, N. Y.—Paving, Sewer.—John M. Huller, 53 Western Ave., Albany, at \$33,675, for improving Orange St., at \$7,121 for improving Stanwix St. and at \$2,561 for sewer in Erie and Champlain St. Above item appeared in our Oct. 14 issue with name of contractor given as George Holler.

Albany, N. Y.—Barge Canal Work.—E. M. Graves, Cleveland, O., at \$1,047,994, for Contract No. 61, improvement of barge canal for 7.39 miles. The work includes 48,500 cu. yds. grubbing, 917,500 cu. yds. excavation, 660,000 cu. yds. embankment, 10,750 cu. yds. concrete, etc.

Albany, N. Y.—Bridges.—Penn Bridge Co., Beaver Falls, Pa., at \$23,675, for furnishing

and erecting five steel highway bridge superstructures at various points on New York State Barge Canal.

New York, N. Y.—Concrete Work.—Turner Construction Co., 11 Broadway, New York, for all the reinforced concrete floor and roof slabs, as well as for the fireproofing of all exposed steel work in the Maxine Elliott Theatre now under construction at 107 to 113 W. 39th St., New York, according to the plans of Marshall & Fox, of Chicago, Architects, and John McKee, General Contractor. Work will be undertaken at once.

New York, N. Y.—Concrete Floors.—Turner Construction Co., 11 Broadway, New York, for the reinforced concrete floors in connection with the new Grand Central Station work. The new contract includes the baggage room floor and the roof of the north-east wing of the new station. A total of about 45,000 sq. ft. of floor will be constructed. Work will be undertaken at once.

Shortsville, N. Y.—Water Works.—Contracts for constructing water works for this town have been let as follows: Cast Iron pipe and specials, Charles Millar & Son Co., Utica, \$23.50 a ton for pipe and 25 cts. a pound for specials; pumps and motors, Gould Manufacturing Co., Seneca Falls, two of each, complete, \$2,200; tank and tower, Des Moines Bridge & Iron Works, Des Moines, Ia., \$4,200; building pump house, laying pipes, etc., to Dennison & Co., Rochester, \$6,611.

Syracuse, N. Y.—Hotel.—Esenwein & Johnson have the contract for the new \$800,000 Onondaga Hotel in this city.

Bellaire, O.—Paving.—John B. Shannafelt, for paving 32nd St. with brick.

Mansfield, O.—Bridge Work.—Hughes & Keenan, for moving and setting up old Ashland Ave. bridge at North Park; Samuel Liston was awarded contract for abutment work.

Portsmouth, O.—Sewer.—H. T. Hatton, at \$1,576, for high school sanitary sewer.

Steubenville, O.—Sewers.—J. H. Vau-meter, at \$2,918, for sewer in Linden Ave.; Emohas Sweeney, at \$1,745, for sewer in 11th St.

Wooster, O.—Abutment Work.—William Levers, for rebuilding abutments of bridge on West North St.

Afton, Okla.—School.—T. Tarrant, for building \$25,000 school house for this city.

Ontario, Ore.—Bridge.—Inter-Mountain Bridge & Construction Co., at \$13,500, for the construction of the combination steel and wooden bridge to be constructed across Snake River. Bridge will be about 500 ft. long and 20 ft. wide and will have three 150-ft. steel spans, supported by steel and concrete piers constructed of steel tubes filled with concrete and properly protected by concrete cribs.

West Chester, Pa.—Bridge.—Logan Contracting Co., 227 W. 128th St., New York, at \$3,500, for the construction of a reinforced concrete bridge, single arch 50 ft., at Devon, Pa., over the Darby Creek. Work has been started.

Easton, Pa.—Bridge.—R. T. & C. D. Stewart Construction Co., at \$2,700, for constructing bridge in Forks Township for county.

Harrisburg, Pa.—Grading.—United Ice & Coal Co., for grading on Sycamore St.

Spartanburg, S. C.—Railroad Work.—MacArthur Bros. Co., who have the general contract for building roadbed of C. C. & O. R. R. from Bostic, N. C., to Spartanburg, have awarded sub-contracts as follows: Section from Bostic, N. C., to Second Broad River, a distance of about five miles, to J. Nichols, of Parkburg, W. Va.; from Second Broad River to Floyd Creek, a distance of five miles, to Purcell, Allen, Shehan & Co., of Washington, D. C.; from Broad River to Little Buck Creek, to Williams, Lewis & Spradlin, of Atlanta, Ga.; from Picolet River to Peters, a distance of three miles, to Reagan & Yale; from Floyd's Creek, south, a distance of ¾ of a mile, to M. M. Schlitz, of Knoxville, Tenn.; from Station 116 to Station 513, 1¼ miles, to R. L. McCurry & Co., of Marion, N. C.; from Station 513 to Station 588, 1½ miles, to A. G. Fretwell, of Anderson, S. C.; from Station 588 to Broad River, 1 mile, to Mason Bros., of Knoxville, Tenn. Most of the heavy masonry work has been awarded to J. C. Dunn & Co., Century Bldg., Cleveland, O., and to Thomas Shehan, of Nashville, Tenn. J. C. Dunn & Co., of Cleveland, have the contract to build over 20,000 yds. of concrete work, including the crossings at Broad River, Picolet and Lawson's Fork. All of the trestle work has been awarded to H. J. Collier & Co., Cleveland, O.

Platte, S. Dak.—Water Works.—Morava Construction Co., 85th St. and Stewart Ave., Chicago, Ill., at \$15,400, for constructing steel

water tower and tank and laying 11,500 ft. of water mains.

Memphis, Tenn.—Paving.—H. P. Streicher, Toledo, O., for four miles of asphalt paving on Madison Ave.

Galveston, Tex.—Drain.—Kelso & Vautrin, at \$18,406, according to reports, for extending 15th St. drain.

Salt Lake City, Utah.—Grading.—Ely Construction Co., Springville, Utah, for grading seven miles for the Southern Utah Ry. Co. The contract was let by the Consolidated Fuel Co., A. A. Sweet, Manager, which controls the above road. Contracts for 11 additional miles are to be let.

Salt Lake City, Utah.—Sewer, Paving.—P. J. Moran, Salt Lake City, at \$3,660, for construction of paving extension No. 47; V. P. Strange, Salt Lake City, at \$12,774, for constructing sewer extension No. 203.

Salt Lake City, Utah.—Sewer.—Bids were received Oct. 9, by Board Public Works, L. C. Kelsey, City Engineer, for constructing sewer extension No. 199, the contract being let to Jas. Kennedy Construction Co., Salt Lake City, at \$31,211. The bids received were as follows: (1) standing by Davis & Heuser, Salt Lake City; (2) for J. D. Hanley, Salt Lake City; and (3) for Jas. Kennedy Construction Co.:

BIDS RECEIVED OCT. 9, AT SALT LAKE CITY, UTAH, FOR SEWER WORK.

	Quantities.	(1)	(2)	(3)
Excavating and back-filling, per cu. yd.....	14,919.36	\$1.67	\$1.75	\$1.25
Furnishing and laying vitrified pipe, including 4-in. bends per lin. ft.				
8-in. lin. ft.....	5885.0	.45	.49	.38
10-in. lin. ft.....	4170.0	.55	.72	.50
12-in. lin. ft.....	3410.0	.70	.68	.66
15-in. lin. ft.....	3220.0	.90	.95	1.00
Re-laying paving, per sq. yd.....	60.0	3.00	2.80	2.50
Re-laying 4-ft. cement walk, per sq. ft.....	224.0	.25	.17	.20
Constructing manholes, each.....	40	60.00	53.00	55.00
Constructing flush tanks, each.....	12	130.00	150.00	125.00
Total		\$37,825	\$38,560	\$31,211

Upton, Utah.—Bridge.—W. H. Staley, Upton, for constructing bridge over Chalk Creek at Upton.

Lynchburg, Va.—Building.—Jones & Adams, for erecting 4-story building, to cost \$30,000, for Virginia Christian College.

Cashmere, Wash.—Water Works.—Ball & McNeerney, Seattle, for installing the new water works here.

North Yakima, Wash.—Sewer.—W. W. Pettijohn, at \$2,470, for sewer in Blocks 25 and 26.

Colville, Wash.—Bridge.—Charles G. Sheely, Denver, Colo., at \$3,560, for bridge at Laurier, and at \$3,347, for bridge at Napoleon Mine.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States.

Gadsden, Ala.—Surveys and soundings are now being made for the new bridge, which according to reports, the Louisville & Nashville R. R., E. E. Kuersteiner, Bridge Engineer, Louisville, Ky., proposes to build over the Coosa River.

Camden, Ark.—County Commissioners are to build a \$25,000 bridge over the Ouachita River.

Malvern, Ark.—County Commissioners are to construct bridge over Ouachita River at Greens Ferry.

Fine Bluff, Ark.—County Board has made appropriation for constructing bridge over Arkansas River near this city.

Pasadena, Cal.—City and county may construct new bridge over the Arroyo Seco at the foot of California St.

Augusta, Ga.—Nisbet Wingfield, Commissioner of Public Works, estimates cost of reconstructing the Center St. bridge at \$65,000—\$20,000 for substructure and providing draw span and \$45,000 for the superstructure.

Ottawa, Ill.—Following bids were received Oct. 6 by City Clerk, for constructing bridge over Illinois River:

Modern Steel Structural Co., Waukesha, Wis.: Superstructure, \$61,492; Bascule lift, \$2,000. King Bridge Co., Cleveland, O.: Superstructure, \$82,900; Decatur Bridge Co., Decatur, Ill.: Superstructure, \$82,500; Bascule lift, \$2,000; substructure, removal of old bridge, \$3,600; concrete per cu. yd., \$21. Wisconsin Bridge and Iron Co., Milwaukee, Wis.: Superstructure, \$74,400; Bascule lift, \$2,000. A. M. Blodgett Construction Co., Kansas City, Mo.: Superstructure, \$79,500; Bascule lift, \$2,000; substructure, removal of

old bridge, \$6,734; concrete, per cu. yd., \$13.50. American Bridge Co., New York: Superstructure, \$87,520; Bascule lift, \$2,000. Penn. Bridge Co., Beaver Falls, Pa.: Superstructure, \$82,200. Pan-American Bridge Co., New Castle, Ind.: Superstructure, \$79,600; Bascule lift, \$2,000; substructure, removal of old bridge, \$8,000; concrete, per cu. yd., \$18. Joliet Bridge and Iron Co., Joliet, Ill.: Superstructure, \$99,000; substructure, removal of old bridge, \$2,400; concrete, per cu. yd., \$16.

Streator, Ill.—City Clerk has been instructed to secure plans and specifications for a concrete bridge. A 160 ft. arch bridge may be erected.

Peoria, Ill.—Peoria & Pekin Union Ry., Stanley Millard, Chief Engineer, Peoria, Ill., may erect a new \$500,000 bridge in this city early next year.

Columbus, Ind.—Bartholomew and Decatur Counties are considering building an \$8,000 bridge over Clifty, at Galbreath Ford.

Connersville, Ind.—Commissioners of Fayette and Wayne Counties have been in conference to decide on building of joint county bridges.

Princeton, Ind.—County Commissioners have adopted plans for a 105 ft. span 16 ft.

roadway, high truss bridge to be erected over Patoka River at Severin site.

South Bend, Ind.—County Commissioners have decided to build a reinforced concrete structure to replace old bridge at Logan St., Mishawaka.

Pikeville, Ky.—J. P. Power, W. K. Steel and J. F. Butler have been appointed Special Commissioners to have charge of building new county bridge over the Big Sandy River at Pikeville.

Louisville, Ky.—Commissioners of Jefferson and Hardin Counties are considering erecting a \$25,000 bridge over Salt River at West Point.

Lawrence, Mass.—A majority report of Central Bridge Commission to City Council recommends that immediate action be taken toward the issuance of the \$500,000 of bonds authorized by the state legislature for constructing the bridge.

Kansas City, Mo.—Board Public Works has instructed J. L. Darnell, City Engineer, to prepare preliminary plans and estimates for a bridge across the Blue River at Independence Ave. The bridge will cost about \$25,000.

Missoula, Mont.—William Oliver Bridge Co., Spokane, Wash., which was awarded contract by County Commissioners for constructing Higgins Ave. bridge, has withdrawn its bids, and work will probably be readvertised. The bridge is to cost about \$130,000.

Mount Holly, N. J.—Burlington County Freeholders and Burlington County Ry. Co. are to construct joint bridge at Hartford.

Omaha, Neb.—Ordinance is before City Council directing Union Pacific R. R. to build a viaduct over its tracks at 29th St.

Fort Hunter, N. Y.—All bids for building bridge over Schoharie River at this place have all been rejected as being above the \$25,000 allowance. New plans are being prepared.

North Tonawanda, N. Y.—New York Central & Hudson River R. R. is stated to have had plans prepared for a new bridge for its Canandaigua branch over the Erie Canal here.

Cleveland, O.—County Commissioners will erect new bridge, probably of concrete, over Mostick Road, Rock River. Bridge will cost about \$15,000. A. B. Lea is County Engineer.

Dayton, O.—County Commissioners will have work started in early spring on reinforced concrete bridge to be erected over the Miami River at Needmore Road. Mr. R. Klinginger, County Engineer, prepared the plans. The bridge will cost about \$18,000.

Reading, Pa.—County Court has approved

proceedings for bridges in Exeter and Douglass Townships.

Linden, Tenn.—County Court has voted \$1,000 to build a bridge over Buffalo River near Standing Rock.

Dallas, Tex.—Jack Whit, County Engineer, has completed surveys of the bridges over the Trinity River at Molloy, Wilmer and Hutchins, for the making of estimate of the cost of raising the bridges or putting in draws.

Manchester, Va.—Construction of a new bridge between this city and Richmond is under consideration and Council has appointed a committee, of which W. D. Ferguson, W. W. Workman and L. R. Brown are members, to consider the question. The committee will have power, it is said, to secure engineering advice.

Marinette, Wis.—City Engineer Hills is preparing designs for a new approach to the lower drawbridge from the Sawyer Goodman Island. The designs will provide a structure with steel girders and stringers, with the lower portion filled in to meet the spans of steel.

Appleton, Wis.—City Engineer Dodge has made drawings for the proposed concrete bridge to be constructed across the Pacific St. ravine to take the place of the structure that is now in use. The proposed bridge will be 330 ft. in length, will be entirely of concrete, and will have a 24-ft. driveway with a 5-ft. walk on each side.

Milwaukee, Wis.—C. J. Poesch, City Engineer, has been directed to make an estimate of cost of constructing a viaduct over the Menominee Valley at 35th St.

Railroads.

Items Arranged Alphabetically by States.

Dothan, Ala.—Atlanta & Saint Andrews Ry., A. B. Steele, President, Atlanta, Ga., is stated to be planning to absorb the Abbeville Southern branch and to extend the A. & S. A. Ry. further north.

Batesville, Ark.—Missouri, Arkansas & Southwestern Ry. Co. is reported to be taking steps to begin construction work on its proposed line from Batesville to Black Rock, Hoxie and Imboden. Surveys have been made for this portion of the line and part of the right of way has been secured. I. J. Matheny, Batesville, is Secretary.

Caddo Gap, Ark.—Advices from Little Rock, Ark., state that A. V. Alexander, who recently bought a timber tract of several thousand acres near Holly, Montgomery County, will build a short line of railroad to connect his saw mill, to be established near Holly, with the Iron Mountain branch at Caddo Gap.

San Luis Obispo, Cal.—Pacific Coast Ry., J. Burke, Roadmaster, San Luis Obispo, is considering extending a branch to Gary, four miles. The road is narrow gauge.

Atlanta, Ga.—The Governor of Georgia has appointed a special commission, of which James R. Gray, Atlanta, is a member, to investigate the question of extending the state railroad to the sea with convict labor, under the resolution adopted by the general assembly at the special session.

Evansville, Ind.—Directors of Evansville & Mt. Carmel R. R., a proposed extension of the Big Four from Evansville to Mt. Carmel, Ind., state that the road will be built as soon as financial conditions improve. At a recent meeting the following directors were elected: W. C. Brown, C. E. Schaff, E. L. Glennon and J. Cartenson, of New York; J. Q. Vanwinkle, of Cincinnati; Robert Davison and James T. Walker, of Evansville.

Covington, La.—Construction work on the New Orleans Great Northern R. R. has been ordered resumed and it is hoped to put the New Mandeville line in operation by Nov. 15 and the Tylertown line in operation by Dec. 25. No date has been fixed for opening the main line between New Orleans and Jackson, Miss., but the construction of this line will be actively pushed. N. G. Pearsall, Covington, La., is General Manager.

Springfield, Mass.—Boston & Albany R. R., E. E. Stone, Engineer of Construction, Springfield, has secured land on which to increase capacity of its Merrick yards, and also on which to erect a new 70-stall roundhouse.

Collins, Miss.—Okotoma Saw Mill Co. of this place, recently incorporated, may connect its railroads from this city to Ellisville.

Prattsburg, N. Y.—The construction of a railroad from Prattsburg to Italy Hill, thence to Potter Center, then to Hall's Corners, where connections will be made with the Northern Central, is under consideration. From Halls the road will go to Geneva, a total distance of about 35 miles. Walter

Drow, Pulteney, N. Y., is promoting the project.

Davenport, Ia. Estimates based on the preliminary surveys for the proposed Davenport & Manchester Interurban Railway have been submitted to the stockholders. According to report the Manchester line will be 55 miles long. F. W. Rank, Moline, Ill., is secretary.

Binghamton, N. Y. Work is to be started shortly on the construction of terminal yard at North Griswold St. for the Delaware & Hudson R. R.

Port Clinton, O. E. H. Brennan has received the project for constructing a railroad from Marblehead through to Kingsway, connecting with a number of roads. The matter was under consideration about 15 years ago and at that time right of way was secured and some grading done.

Lamar, Okla. Announcement has been made that the Missouri, Oklahoma & Gulf Ry., William Kenedick, President, Kansas City, Mo., will immediately build an extension of its line from the present southern terminus at Lamar into Texas, passing through Denison and Sherman, with a probability of an ultimate extension to Galveston.

Gage, Okla.—Surveys for the Beaver Valley & Northwestern R. R. have been completed between Hooker, Texas County, and Gage, Ellis County, a distance of 107 miles. All maps are to be completed at once in order that contracts for construction may be let.

Okeene, Okla.—The Northwestern Development Co. has been organized at Okeene for the purpose of building a railroad from Oklahoma City northwest to some point in Southwestern Kansas for a connection either with the Santa Fe or Rock Island. W. E. Miller of Kingfisher is president; H. W. Side of Kell, C. K. Bozman of Okeene, H. D. Cunningham of Fairview, W. C. Douglas of Whitehorse, E. D. Gillespie of Toga and Joe Sherman of Estelle, vice-presidents; Charles Clark, secretary and treasurer.

El Reno, Okla.—Advices from this city state that work is to be started shortly on the construction of the El Reno, Red River & Pacific Ry., which has been promoted by L. B. Pennell and H. C. Bradford. The financing of the road is reported to have been completed.

Dallas, Tex.—Matter of constructing the Dallas & New Mexico Ry. is being taken up, and representatives of the project have been interesting citizens in the northwestern part of the state. The property was recently purchased by R. C. Megargel, New York. Ben Cain, Tyler, Tex., is also interested.

San Antonio, Tex.—Charles B. Mullaly, President Business Men's Club, is advocating the construction of a direct line railroad from San Antonio to Brownsville.

Fort Worth, Tex.—Track laying on the line of Estacado & Gulf R. R. has been started out of Roby. The road will run to Fort Worth and south to the Gulf. W. A. Butts is President and headquarters of road are in Fort Worth.

Wichita Falls, Tex.—Advices from this place state that the Wichita Falls & Southern Ry., A. J. Robinson, Chief Engineer, Wichita Falls, is to be extended south from Newcastle, Young County, to Llano, a total distance from Wichita Falls of about 250 miles. The Wichita Falls & Northwestern Ry., owned by the same interests, and in operation to Frederick, Okla., 50 miles, is also to be extended to Altus, Okla.

Index, Wash.—Index-Galena Co., which has large timber holdings on the Shykomish River, has purchased from Nicholas Rudebeck, of Everett, the franchise and right of way of the railway between Silver Creek and Index, together with tools and several carloads of steel rails which were brought in here over a year ago by Rudebeck. The consideration was \$20,000.

Superior, Wis.—Flag River R. R. Co. has been incorporated and proposes to build a railroad between Superior and Bayfield, along the south shore of Lake Superior. B. C. Cook, Superior, is President, and A. W. McLeod, Washburn, Wis., is Secretary.

Valdez, Alaska.—Leopold, Hirsch & Co., London, England, has taken over the interests in Alaska of the Valdez-Yukon Ry. Co. and the Hubbard-Elliott Mining Co. According to the terms of the sale the London capitalists are given three years in which to complete the railroad to the interior copper districts. In addition to the main line to the copper mines, a branch is projected to run from the Copper River across the Tazlina divide 60 miles to the Matanuska coal fields, where the company also owns property. As soon as the coal mines are reached smelters will be constructed at some point on Valdez Bay. Preliminary work may be started this fall.

Electric Railways.

Items Arranged Alphabetically by States.

Alameda, Cal.—Alameda Improvement Club is taking steps to secure the building of an independent trolley line for the extreme west end of Alameda.

Los Angeles, Cal.—M. J. Nolan has secured franchise for electric railway on West Washington St., from La Salle Ave. to western city boundary, a distance of about one mile. The franchise will be turned over to the Los Angeles Ry. Co. and the new road, which will extend beyond the city limits about a mile and a half, will be operated in connection with the general system of that company.

Sacramento, Cal.—California Central Traction Co., operating an electric railway between Stockton and Lodi, has asked franchise to enter this city. It is said that complete rights of way have been secured and necessary capital obtained, so that the road will be built as soon as the franchise is granted.

Clinton, Ia.—Council has adopted ordinance granting new franchise to Clinton Street Ry. Co.

Davenport, Ia.—Tri-City Ry. Co., J. F. Porter, President, will rebuild its track in West 3rd St., from Marquette St. west.

Council Bluffs, Ia.—Independent Transportation Co. has appointed committee consisting of A. T. Flickinger, H. F. Knudson and F. M. Compton to take steps to secure franchise over streets in this city. The company proposes to operate its lines with gasoline motor cars or electric power.

Peoria, Ill.—It is probable that construction work will be started in the spring on the proposed interurban railroad between this city and Rock Island. Right of way for the entire distance has been secured and surveys for part of the way have been made by Roberts & Abbott, Cleveland, O. The project is being promoted by S. F. Moore, Cleveland, O.

Bluffton, Ind.—Advices from this city state that the proposed Cleveland-Indianapolis railroad has been financed to such an extent that construction work may be started soon on the section between Norwalk and Bluffton.

Greencastle, Ind.—County Commissioners have granted a franchise to the Indianapolis, Cloverdale & Terre Haute Interurban Co., which gives the company the right to use, cross and follow where necessary the roads of the county.

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ROAD WORK.

NOTICE TO CONTRACTORS.

STATE OF NEW YORK, Office of the State Engineer and Surveyor, Albany, N. Y.—Pursuant to the provisions of Chapter 115 of the Laws of 1898, as amended, and 330, Laws of 1908, sealed proposals will be received by the undersigned at his office in the State Hall at Albany, on Monday, the 9th day of November, 1908, at 12 o'clock noon, for the improvement of the following public highways:

Road	No.	Name of Road.	County.	Miles.
309..Post, Sec. 2.....	11ster			6.480
321..Reservation Road				
—Varick	Seneca			4.319
346..Sprakers — Rural				
Grove, Sec. 2..	Montgomery			2.520
347..Canaanahobie —				
Sharon Springs,				
Sec. 2.....	Montgomery			2.940
392..Oak Orchard, Sec.				
1	Orleans			3.342
412..Port Jervis—Sullivan Co. Line.				
Sec. 1.....	Orange			5.740
413..Highland Mills—				
Monroe	Orange			3.270
410..Philadelphia	Jefferson			5.400
414..Riverside Drive..	Broome			1.149
463..Manheim Center				
—Salisbury	Herkimer			5.520
464..Salisbury Center				
—Stratford	Herkimer			5.460
480..Buffalo, Sec. 4.....	Monroe			3.020
481..Despatch—Pitts-				
ford	Monroe			.990
489..Tully	Onondaga			4.440
491..Hilton—Bartletts				
Corners	Monroe			1.010
493..Mendon — Pitts-				
ford	Monroe			6.260
504..Troy — Speigle-				
town	Rensselaer			1.690
536..Schodack Center				
—Nassau	Rensselaer			5.190
513..Johnstown—				
Broadalbin, Sec.				
2	Fulton			6.350
547..Willetts — East				
Williston —				
Westbury Pond, Nassau				6.430
553..Fly	Onondaga			2.336
554..Fabius	Onondaga			4.910

Sealed proposals will also be received by the undersigned at his office in the State Hall, at Albany, on Wednesday, the 11th day of November, 1908, at 12 o'clock noon, for the improvement of the following highways:

Road	No.	Name of Road.	County.	Miles.
564..Rome: Augusta—				
Westmoreland, Oneida				5.020
571..Spring Ave., Troy				
—Poestenkill	Rensselaer			2.610
585..Town's Corners				
—County Line, Putnam				3.930
601..Troy — Schenec-				
tady, Sec. 3.....	Albany			3.880
610—Mechanicville—				
Malta	Saratoga			7.120
612..Pawling — Dover				
Town Line.....	Dutchess			2.920

627..Wicopee — Beck-	
man	Dutchess 8.100
630—Troy and Schen-	
ectady, Sec. 4..	Albany 2.240
635..Geneva — Hall's	
Corners	Ontario 5.040
636..Stanley—Geneva..	Ontario 3.160
642..Angola — Evans	
Center; Angola	
—Brant	Erie 6.900
644..Alden — Town	
Line, Sec. 2..	Erie 730
645..Orchard Park—	
Griffins Mills..	Erie 4.640
646..Indian Fields —	
Dormansville ..	Albany 4.120
650..Hudson—Hollow-	
ville	Columbia 5.660
652..Champlain —Per-	
rys Mills..	Clinton 3.250
654..Oswego — Mexi-	
co, Sec. 2..	Oswego 5.350
663..Otselic — South	
Otselic, Sec. 2..	Chenango 4.420
681..Ithaca — Dry-	
den, Sec. 1....	Tompkins 5.230
685..Stirling — Oswe-	
go	Cayuga 4.880
690..Monsey — Egypt	
Corners	Rockland 4.250

Sealed proposals will also be received by the undersigned at his office in the State Hall, at Albany, on Friday, the 13th day of November, 1908, at 12 o'clock noon, for the improvement of the following highways.

Road

No.	Name of Road.	County.	Miles.
708..	Sidney — Una-		
dilla	Otsego 4.680		
713..	North Tonawan-		
da—Shawnee ..	Niagara 5.130		
714..	Dansville — Mt.		
Morris, Sec. 1..	Livingston 5.370		
723..	Whitehall — Fort		
Ann Town Line.	Washington ..4.770		
725..	Grand Central		
Avenue, Sec. 2..	Chemung 900		
727..	Chittenango —		
Oneida, Sec. 1..	Madison 5.150		
734..	Potsdam — Par-		
ishville, Sec. 1..	St. Lawrence..5.120		
736..	North Creek—		
County Line..	Warren 4.120		
737..	Cortland — Trux-		
ton—Cuyler ...	Cortland 5.790		
747..	Delhi — Bloom-		
ville	Delaware 5.910		
750..	Clarence Center..	Erie 5.950	
754..	Bath — Savona..	Steuben 1.460	
765..	Ossining — Kit-		
chewan	Westchester ..5.860		
769..	Amawalk—Woods		
Bridge	Westchester ..4.210		
770..	Golden Bridge—		
Turk Hill.....	Westchester ..3.850		
784..	Cooperstown —		
Three Mile			
Point	Otsego 3.120		
788..	South Schenec-		
tady — Maria-			
ville	Schenectady ..7.320		
794..	Huntington —		
Amityville	Suffolk 10.140		
795..	Jeffersonville —		
Kenoza Lake—			
Fosterdale	Sullivan 6.200		
796..	Greenville —Cox-		
sackie, Sec. 1..	Greene 4.620		

Plans and specifications may be seen and proposal forms obtained at the office of the division engineer of the Eastern Division in the State Hall, at Albany, N. Y., for roads in the counties of Albany, Clinton, Columbia, Delaware, Dutchess, Fulton, Greene, Herkimer, Montgomery, Nassau, Orange, Otsego, Putnam, Rensselaer, Rockland, Saratoga,

Schenectady, Suffolk, Sullivan, Ulster, Warren, Washington and Westchester; at the office of the division engineer of the Middle Division in the Weighlock Building, Syracuse, N. Y., for roads in the counties of Broome, Cayuga, Chenango, Cortland, Jefferson, Madison, Oneida, Onondaga, Oswego, St. Lawrence, Seneca and Tompkins; and at the office of the division engineer of the Western Division in the Triangle Building at Rochester, N. Y., for roads in the counties of Chemung, Erie, Livingston, Monroe, Ontario, Niagara, Orleans and Steuben.

The attention of bidders is especially called to Paragraph 7 of "Information for proposers" on page 2 of the specifications. Proposals for each road must be presented in a separate, sealed envelope endorsed on the outside with the name and number of the road for which the proposal is made.

Each proposal must be accompanied by a New York draft or a certified check payable at sight to the order of the State Engineer and Surveyor for an amount equal to at least five per cent of the amount of the proposal which such draft or check accompanies, which draft or check will be held by the State Engineer until the contract and bond are duly executed. The successful bidder will be required to give a bond for fifty per cent of the contract price, such bond to be executed by a surety company to be approved by the State Engineer and Surveyor.

The right is reserved to reject any or all bids.

FREDERICK SKENE,
State Engineer and Surveyor.

SEWERS AND SEWAGE DISPOSAL WORKS.

Hartwell, Ohio.

Sealed bids will be received by the Council of the Village of Hartwell, State of Ohio, until 12 o'clock noon, Nov. 16, 1908, for furnishing the necessary labor and materials for the construction of sewers and for the construction of sewage disposal works, according to the plans and specifications on file in the office of Village Clerk, and with C. L. Swain, No. 57 Atlas Bank Building, Cincinnati, Ohio, and with Riggs & Sherman Company, 613 The Nasby, Toledo, Ohio.

Each bid must contain the full name of every person or company interested in the same, and be accompanied by a bond in the sum of One Thousand Dollars (\$1,000.00) to the satisfaction of the Council or a certified check on some solvent bank, as a guaranty that if the bid is accepted, a contract will be entered into and its performance properly secured.

The right is reserved to reject any and all bids. By order of the Council of the Village of Hartwell.

FRANK J. SPINNING, Clerk.

DRAINAGE DITCH.

Northwood, Iowa.

Sealed bids will be received by the County Auditor of Worth County, Iowa, up to 1 o'clock p. m., Nov. 11, 1908, for the construction of a drainage ditch and tile drains in Worth County, consisting of open ditch estimated at 74,110 cu. yds., and 27,941 lin. ft. of 6, 8, 10, 12 and 15-in. tile. Work on open ditch to be completed by December 1, 1909, and the tile drains to be completed by Dec. 1, 1910.

IVER IVERSON, JR., County Auditor.

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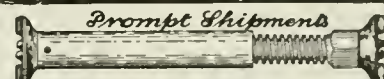
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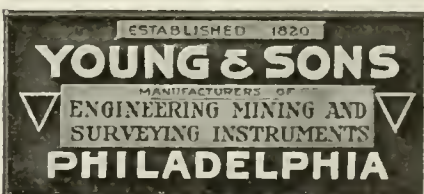
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DRAINAGE DITCH.

Eldora, Iowa.

The Board of Supervisors of Hardin County, Iowa, having ordered the construction of a ditch and drain in Hardin County, Drainage District No. 3, situated in Alden, Hardin, Ellis and Jackson Townships, aggregating 269,654 cu. yds. of open work, notice is hereby given that sealed bids for the construction of said improvement will be received by the Board of Supervisors, at the office of the County Auditor, at Eldora, Iowa, until 1:30 p. m., Monday, Nov. 9, 1908. The work to be commenced on or before March 1, 1909, and to be completed on or before the first day of September, 1909.

R. A. VIGERS, County Auditor.

List of Contractors' Supplies.

If you wish the catalogs of the leading manufacturers of any tool or machine mentioned below, send us a postal card, giving your address and business, and the list number of article of which you want catalogs.

This will save you the trouble of writing several letters to different manufacturers. Should you later on have correspondence direct with the manufacturers, we shall appreciate it if you will state in your letters that you are indebted to ENGINEERING-CONTRACTING for the introduction. Such a statement will be mutually beneficial.

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| 7 Asphalt tools. | 110 Creosoting. | 248 Hoses. | 412 Rails, second hand. |
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| | 114 Crushers, rock. | | 414 Rammers, pneumatic. |
| | 116 Culverts. | 260 Injectors. | 415 Recording instruments. |
| 10 Ballast spreaders. | | 261 Insulated wire. | 416 Riveters, pneumatic. |
| 12 Ballast unloaders. | | 262 Iron. | 418 Road machinery. |
| 14 Bearing, ball and roller. | 120 Derricks and fittings. | 264 Iron, corrugated. | Rock crushers. See 114 |
| 16 Bearings, self-oiling. | Draftmen's instrs. See 154. | 266 Iron, sheet. | 422 Rollers, horse. |
| 18 Bellows. | 124 Dredges. | 270 Jacks, hydraulic. | 424 Rollers, steam. |
| 20 Belt dressing. | 126 Drill sharpeners. | 272 Jacks, screw. | 425 Roofers' supplies. |
| 22 Belting, canvas. | Drills, air. See 136. | 274 Jacks, track. | 426 Roofing. |
| 24 Belting, chain. | 128 Drills, core. | Jacks, trench. See 502 | 427 Rope drive. |
| 26 Belting, leather | 130 Drills, diamond. | | 428 Rope, manila. |
| 28 Belting, rubber. | 132 Drills, pneumatic plug. | 280 Laborers supplied. | 430 Rope, wire. |
| 30 Blacksmiths' tools. | 134 Drills, ratchet. | 282 Lamp posts. | |
| 31 Blasting batteries. | 136 Drills, rock. | 284 Lath, metal. | 438 Sand blast apparatus. |
| 32 Block machines, cement | 138 Drills, well. | 286 Lights, contractors'. | Sand pump. See 392. |
| and concrete. | 140 Dynamite. | 288 Lime. | 440 Saw mills, portable. |
| 33 Blocks, tackle. | 142 Ducts, vitrified. | 290 Locomotives, dinkey. | Scale box. See 462. |
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| 38 Boilers. | | 296 Locomotives, geared. | 446 Scrapers, road. |
| 39 Boiler covering. | Electric motors. See 324. | 298 Locomotives, steam. | Scrapers, wheel. See 524 |
| 40 Brakes, air. | 152 Elevators, bucket. | 300 Lubricants. | Screens, rotary. |
| 42 Brick, building. | 154 Engineers' instruments. | 302 Lumber, creosoted. | 450 Second hand outfits. |
| 44 Brick, paving. | 156 Engines. | 310 Machine tools. | Sewer braces. See 502 |
| 45 Brick machines. | 158 Engines, gas. | 312 Manganese steel. | 454 Sewer cleaners. |
| 46 Bridges. | 160 Engines, gasoline. | 314 Manhole covers. | 455 Sewer traps. |
| 48 Buckets, clam shell. | 162 Engines, hoisting. | 315 Metaline. | Sewer pipe. See pipe |
| 50 Buckets, dumping. | 164 Engines, steam. | 316 Meters, water. | Shafting. |
| 52 Buckets, orange peel. | 166 Engines, traction. | 318 Mineral wool. | 458 Sheaves. |
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| 94 Compressors, air. | 216 Governors, engine. | 362 Pipe, cast iron. | Traction engines. See 166 |
| 95 Conduit, bituminous fiber. | 218 Governors, water wheel. | 364 Pipe, cement. | Track laying mach. See 413 |
| Concrete reinf. See 474. | 220 Graders, elevating. | 366 Pipe, lead. | 499 Track tools. |
| Conduit, vitrified. See 142. | 222 Gaskets. | 368 Pipe, riveted steel. | 500 Tracing cloth. |
| 96 Concrete fence post molds. | 224 Grubbers. | 370 Pipe, vitrified sewer. | 502 Trench braces. |
| 97 Computing machines. | | 372 Pipe, wrought iron. | 504 Trench machines. |
| 98 Contractors' bonds. | 228 Hammers, pneumatic. | 374 Pipe cutting machine. | 506 Turntables. |
| 100 Contractors' supplies. | 230 Hangers, joist. | 375 Pipe tapping machines. | |
| 102 Conveying machinery. | 232 Harness. | 376 Plows. | |
| | 234 Hoists, air. | Plows, unloading. See 12. | 510 Valves, steam. |
| | 236 Hoists, chain, differential. | Pneumatic tools. See 8, | 512 Valves, water. |
| | 238 Hoists, electric. | 132, 416. | 513 Vault lights. |
| | 240 Hoists, gasoline. | | 514 Ventilators. |
| | | 380 Portable railways. | |
| | | 382 Powder, black. | 520 Wagons, dump. |
| | | 383 Prism glass. | 522 Waterproofing. |
| | | 384 Pulleys. | Well drills. See 138. |
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| | | 388 Pumps, electric. | 528 Wheel scrapers |
| | | 392 Pumps, sand. | 530 Windmills. |
| | | 394 Pumps, steam. | 532 Wire cloth. |
| | | 396 Pumps, trench. | Wire rope. See 430. |
| | | 398 Punches, hydraulic. | |

The above is only a partial list of the headings in our Card Index. No matter what you want, TELL US and we will put you in prompt communication with the leading manufacturers, dealers or contractors.

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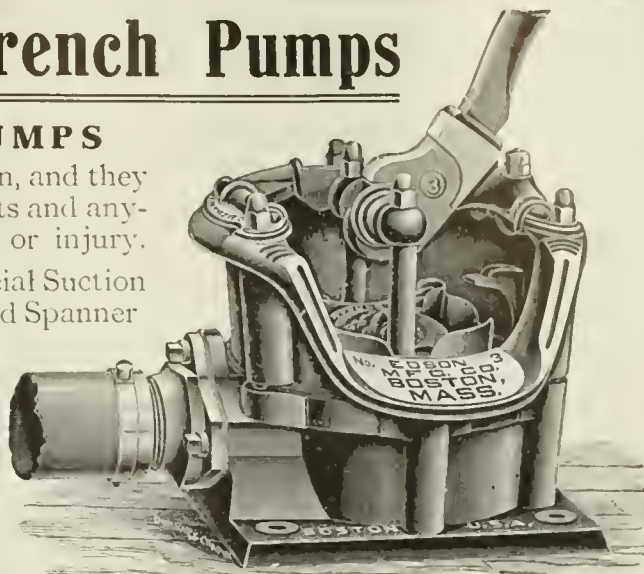
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GENERAL WORK, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday November 2, 1908, at room 705, No. 200 Randolph street, for the general work required in connection with the construction of the new city hall building to be erected on the west half of block 39 original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, General Work," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city of Chicago and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500 will be made in room 705, No. 200 Randolph street, to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.

By PAUL REDIESKE,
Deputy Commissioner.

DRAINAGE WORK.

Velasco, Tex.

Sealed proposals in duplicate will be received by the Board of Drainage Commissioners of the Velasco Drainage District of Brazoria County, Texas, at the office of E. P. Hoefle, Velasco, Texas, until 4 o'clock p. m. of the 10th day of November, 1908, for the construction of Levees, Revetment Work, Ditches, etc., according to the plans and specifications now on file in the office of said Commission, at Velasco, Texas. Bids will be received for the whole work complete, or for any section or division thereof.

R. E. L. STRINGFELLOW, Chairman.
P. F. COMBS, Secretary.

FILTRATION PLANT.

Wilmington, Del.

Sealed proposals will be received by the Board of Water Commissioners at the office of the Water Department, southeast corner Sixth and King Streets, Wilmington, Delaware, until 10:30 a. m. on Monday, Nov. 23, 1908, for the construction of a covered, slow sand filtration plant, together with filtered water reservoir, filter sand washing apparatus and other appurtenances; the kind and the amount of work to be done or furnished under said proposals to be according to plans and specifications which may be seen in detail at the office of the Chief Engineer of the Water Department, southeast corner Sixth and King Streets, Wilmington, Delaware, to which reference is hereby made.

The contract for the doing of the work and the furnishing of all materials and supplies covered by such plans and specifications will be awarded to the lowest and best bidder, provided that the Board of Water Commissioners reserves the right to reject any or all bids.

Each bid must be signed by the bidder and be accompanied by an undertaking signed by the persons offered by the bidder as his sureties, who must, in all cases, be resident freeholders of the City of Wilmington, or a thorough responsible surety company, which company or companies must be acceptable to the Board of Water Commissioners, declaring their consent to be such sureties in the event

of the contract being awarded to such bidder; and if any contract be so awarded, and such bidder shall fail to complete the execution of a contract therefor, with security for its performance approved by the said Board, such bidder and the party or parties, company or companies, so undertaking for him, as aforesaid, shall be liable to pay to the City of Wilmington any damage that may be occasioned to said city by such failure; bond required in the sum of 25% of the contract price.

Form of proposals and contracts may be obtained at the said office of the Chief Engineer of the Water Department.

Copies of the specifications and plans may be secured upon making a deposit of twenty-five dollars, said deposit to be returned upon the return of the plans and specifications.

By order of Board of Water Commissioners.

JOHN A. KIENLE, Chief Engineer.
Attest: CHAS. MCINTIRE, Secretary.

DRAINAGE.

Cerro Gordo, Ill.

Bids are asked by the Commissioners of Union Drainage District, No. 3, Cerro Gordo and Willow Branch Townships, Platt County, Ill., until 1 p. m., Oct. 30, 1908, for furnishing, hauling, laying and back filling various quantities of various size vitrified red clay or shale tile. Plans and profiles may be seen at the Township Clerk's Office, Cerro Gordo, Ill.

W. J. DAY, Engineer, Bement, Ill.
J. C. LOCHER, Clerk, Cerro Gordo, Ill.

CONCRETE WHARF.

Detroit, Mich.

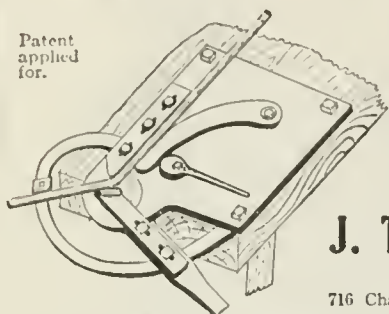
Sealed proposals will be received at the office of the Public Lighting Commission, 40 Atwater Street East, Detroit, Mich., until Monday, Nov. 2, at 4:00 o'clock p. m., for constructing a concrete wharf on the premises of the Commission in the rear of the power house, in accordance with plans and specifications on file in the office of the Commission.

By order of the Public Light Commission.

F. MISTERSKY, Gen'l Supt.

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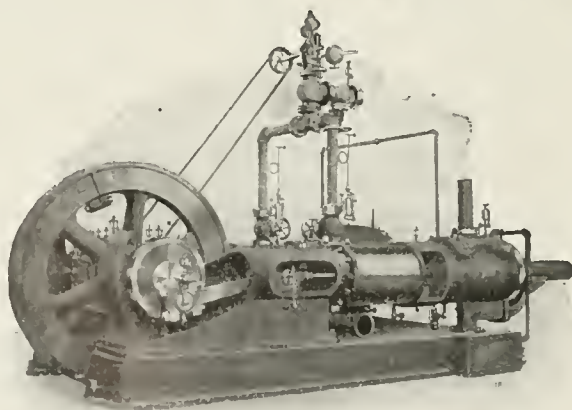
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Hershey S. Welch, City Engineer, North Platt, Neb., says:

"I believe the very satisfactory bid we received on this sewer is due to the announcement of the work in the ENGINEERING-CONTRACTING. I received a large number of letters from contractors, manufacturers, and dealers, all of whom mentioned having seen the advertisement in ENGINEERING-CONTRACTING. You must certainly get results for your advertisers."

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H-52

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One No. 6 Style "K" Gates Crusher, with No. 4 Style "D" to follow with complete equipment of elevators, screens, power plant, etc

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Two No. 0 Smith's on Truck, with Engine and Boiler.

Two No. 1 Smith's on Truck, with Engine and Boiler.

Two No. 2 Smith's on Truck, with Engine and Boiler.

Two No. 2 1-2 Smith's on Truck, with Engine and Boiler.

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Two 1-2 yd. Ransome's on Truck, with Engine and Boiler.

Two No. 17 Cube on Trucks with Engine and Boiler.

Two No. 3 Foote Street Machines complete.

G. C. Marsh Room 970 Old Colony Bldg. Chicago, Ill.

SETTLING BASIN.

Kansas City, Mo.

Sealed bids will be received by the Board of Fire and Water Commissioners at the office of said Board at the City Hall, Kansas City, Mo., until 2 o'clock, on Monday, Nov. 9, 1908, for the construction of a settling basin adjoining the present settling basins at Quindaro, Kans., of either 45 million or 50 million gallons capacity, depending upon the type of construction finally decided on.

A wholly independent proposal is requested upon each of two types of construction, one type embracing earthen embankments capped with a light wash wall, the other type embracing an earthen embankment faced with a reinforced concrete retaining wall with counterforts.

Each bid must be accompanied by cash or a certified check in the amount of Two Thousand (\$2,000) Dollars.

The Board of Fire and Water Commissioners does not bind itself to accept the lowest or any bid offered, and reserves the right to reject any or all bids when it appears to be to the interest of Kansas City so to do, and further reserves the right to accept a bid on either of the two types of construction upon which proposals are requested.

CONCRETE BRIDGE.

Austin, Texas.

Sealed bids will be received by the Commissioners' Court of Travis County, at Austin, Texas, until 11:30 o'clock A. M., Thursday, November 5th, 1908, for furnishing the necessary labor and materials for constructing a reinforced concrete arch bridge over the Colorado River on Congress Avenue in the City of Austin, and for the removal of the steel bridge now there, all in accordance with plans and specifications on file with the County Judge of Travis County.

Copies of the plans and specifications will be furnished upon application to the County Judge, or to Waddell & Harrington, Consulting Engineers, Kansas City, Mo. A certified check for (\$10,000) ten thousands dollars made payable to Jno. W. Hornsby, County Judge of Travis County, shall accompany each bid, as a guarantee that if the bid is accepted a contract will be entered into and its performance secured.

The bridge will consist of eight spans, each 110 feet long at the springing line and having a roadway 38 feet wide and two sidewalks each five feet wide. The Court reserves the right to reject any and all bids.

By order of the Court.

JNO. W. HORNSBY,

County Judge, Travis County, Texas.
Austin, Texas, Oct. 8th, 1908.

For Sale at Once

the following list of machinery and apparatus in good working order, located at

Lincoln Park, Chicago.

1 tandem compound Buckeye engine, size 11x18x16, speed 250 r.

1 simple Ideal engine, size 13x14, speed 250 r.

2 No. 7 type 1, C. F. 6.8-ampere Western Electric D. C. arc dynamos, capacity 100 inclosed arc lamps, speed 650 r.

The following list will be available on or before Jan. 1, 1909:

1 Frazer & Chalmers cross compound Corliss engine, size 17x28x30 in., direct connected to two 110-volt pumps, size 12½x20 in., capacity 8,000,000 gallons in 24 hours, speed 100 revolutions.

1 tandem compound Buckeye engine, size 11x18x16, speed 250 r.

1 Ideal tandem compound engine, size 11x18x14, speed 250 r., direct connected to 100 k. w. G. E. A. C. generator, 2-phase, 60-cycle, 2,300-volt, primary, 110-volt, secondary, speed 250 r., exciter attached.

1 Worthington jet condenser, size 12x14x10 in.

1 tandem compound Dean pump, size 12x18x12x18.

1 boiler feed pump, size 6x1x6.

1 boiler feed pump, size 7½x5x6.

1 simple New York safety engine, size 11x14, speed 250 r.

1 vertical air compressor, size 8½x8½x9.

2 Heine safety boilers, 290 horsepower each, size 48x21x9½ in.

2 No. 7 type 1, C. F. 6.8 ampere Western Electric D. C. arc dynamos, capacity 100 inclosed arc lamps, speed 650 r.

2 type F 6.8 ampere Western Electric D. C. arc dynamos, capacity 60 inclosed arc lamps, speed 1,000 r.

1 45 k. w. 2 phase Westinghouse A. C. dynamo, 60-cycle, 2,300 and 110 volt, with exciter.

1 3-panel marble switchboard, complete with plugs and instruments, size 10x7 ft.

1 1,000-horsepower Stillwell open heater.

96 type 112 D. C. Western Electric inclosed arc lamps, 6.8 ampere.

235 and 414 D. C. Western Electric inclosed arc lamps, 6.8 ampere.

M. H. WEST, Sec. and Supt.,
Lincoln Park Commission, Chicago.

Good Stuff At Right Prices

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One No. 2 Buffalo Mixer with gasoline engine	\$500
One No. 1 McKelvey Mixer, engine and boiler, on wheels	\$325
One 20 H. P. Lidgerwood Hoist, D. C. D. D. with boiler	\$650
One 80 H. P. Single Drum Hoist, link motion, no boiler	\$900
One No. 2 Austin Gyratory Crusher (new)	\$400
One Lot of Paint Machinery. Very cheap.	
One 45 Ton Bucyrus Steam Shovel, 1½ yard	\$2,200

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WANTED—Contractor's superintendent finishing ten thousand yard job brick paving, wants similar position in south or southwest. Graduate Civil Engineer, five years varied experience. Willing to invest \$1,000. O. B., Box 93, Columbia, Missouri.

WANTED—Can you control \$25,000 capital, or promote a company? The advertiser has a new proposition of merit in connection with the street and sidewalk pavement line. Address "M. F. J.," care of Engineering-Contracting, 355 Dearborn St., Chicago, Ill. 16-6t

WANTED—Position with reinforced concrete construction company, by graduate civil engineer. Six years' railway engineering, during which had charge of large amount of concrete work. Middle west preferred. Address "C.," 1462 Independence Avenue, Kansas City, Mo.

WANTED—POSITION as chemist or chemical engineer by graduate of leading technical school. Has had several years of practical experience and can fill responsible position. Best of references. Address Box "P. C.," care Engineering-Contracting, 721 Park Row Bldg., New York City. 17-1f

WANTED—Position.—Structural estimator and designer; all classes of building work; now employed; wants position with architect or contractor in Chicago; ten years' experience. Address Box 47, care Engineering Contracting, 355 Dearborn St., Chicago.

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New light rails and standard sea-
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Two Vulcan shovels, 1½ yard and 2½
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Two 42" gauge saddle tank 9 x 14,
locomotives, saddle tank.

Two 36" gauge locomotives, saddle
tank, 9 x 14.

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Traction engines, hoisting engines, pumps, etc.

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- 3 2-ton Jackson Conveyors.
- 1 Locomotive Crane, 8-ton and clam shell.
- 3 Hoisting Engines.
- 3 13-ton Kelly-Springfield Road Rollers.
- 1 Champion Crusher No. 15.
- 100 Dump Bottom Wagons.
- 3 Road Machines.
- 2 Smith Concrete Mixers.
- 100 Horses and Mules.

And a full and complete Contracting Outfit of plows, scrapers, portable engines, boilers, pumps, blacksmith tools and everything necessary to carry on the contracting business.

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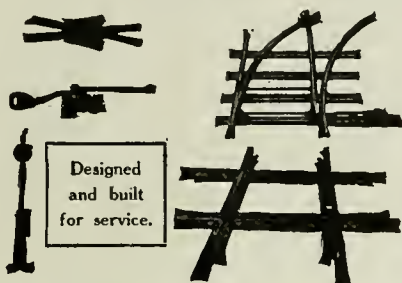
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This photograph shows railroad ties of southern pine that were immersed 15 minutes in hot paint made by this company. After nine years service the ties are as sound as the day they were treated, which means that, at worst, they will have a life of not less



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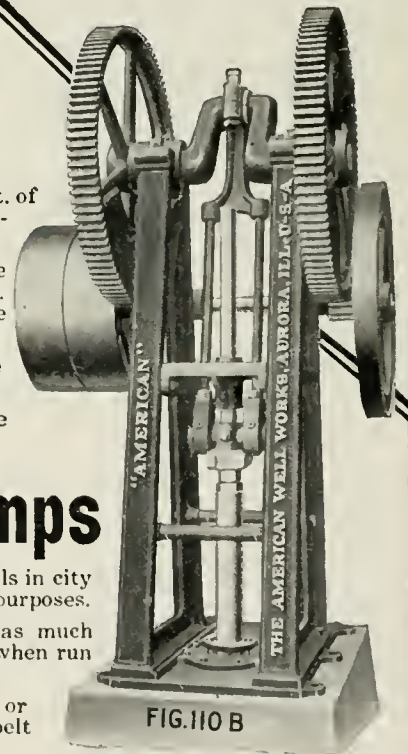


FIG. 110 B

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CONTRACT NEWS

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Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

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The Stripping of Reservoirs with Special Reference to the Water Supply of New York City.

On another page of this issue we publish an article on the stripping of reservoir lands. This subject is an important one inasmuch as many towns and cities are increasing their water supply and building large reservoirs.

Mr. Diven, in his paper, gives two examples, one where the entire area was stripped, and the other where no attempt was made even to clear the water area of trees and brush, and the greater part of the land was swamp land or rice fields. Curiously enough, the trouble from impurities in the water were less in the latter case than in the former.

This subject is now under discussion in New York City. Mr. W. H. Sears, chief engineer of the Aqueduct Commission, has recommended the construction of the Patterson Reservoir on the Croton water shed, and considerable opposition to this project has developed, owing to the fact that the great part of the water area of the proposed reservoir is marshy land.

New York City has allowed large sums of money to be wasted and has permitted many extravagances, during the past decades, acting under the influence of a calamity cry of a possible water famine. To prevent such a famine water from the Catskills is to be brought to the city at a great cost, yet it will be years before the impounding reservoir and aqueduct can be completed. A water famine can readily occur in the meantime. Until the Catskill supply can be brought to the city, the Croton water shed must be relied upon to supply Manhattan and the Bronx. At present there is a great waste of water going over the dams in the Croton water shed. From the time of filling the new Croton reservoir in November, 1907, till March, 1908, according to Mr. Sears, 50,000 million gallons have run to waste, an amount of water large enough, if it could have been stored, to supply the city for about three years.

All the subdivisions of the Croton water shed have been developed for storage purpose, to an average of over 300 million gallons per square mile, while the east branch has now storage for only 125 million gallons per square mile. Building the Patterson reservoir, which is to be situated in this subdivision, will increase the storage to 378 million gallons per square mile. To accomplish this, a masonry dam from 30 to 40 ft. high and two small earthen dikes will have to be built, all of which can be done in two years at an estimated cost of \$3,250,000. This reservoir will have a capacity of 20,000,000,000 gallons, or two-thirds the storage capacity of the New Croton Reservoir, which cost more than \$12,000,000 and was about 15 years in building.

It will thus be seen that for a trifling cost, as compared to the New Croton reservoir, the Patterson reservoir can be built, and the possible water famine averted by storing enough water to last the city more than a year. The city of New York is making a great mistake in spending \$161,000,000 for a new supply from the Catskills before developing the entire Croton water shed, which is right at its door.

Two objections have been made to the construction of this Patterson reservoir, the first being that it cannot be predicted that the reservoir will be filled in any given year, the second being that about three-fourths the area to be submerged is swampy ground. The fact is that, at certain seasons and after very heavy rains, the whole bottom of this basin is flooded and becomes a temporary lake. This, in fact, is the normal condition in winter and spring.

The answer to the first objection is that Croton water shed records of the rainfall and run off for the past forty years show that for nearly half the time there is enough water to fill this additional reservoir, which, once filled, will serve as additional storage. Clearly this is a wise precaution that should not be neglected.

The second objection is answered to a great extent by Mr. Diven's paper.

There are also other considerations, for example, vegetation entirely submerged does not decay. It is true that there is always a very disagreeable odor around new reservoirs that have neither been lined nor stripped, but this odor comes from the edges of the reservoir where the vegetation is alternately covered and exposed.

Mr. Diven shows that where the reservoir was stripped, the conditions steadily grew worse, while with the Charleston reservoir each year the conditions are improving. The Ashokan reservoir in the Catskills is not to be stripped and a large area of it is swamp lands, the West Hurley basin being practically the same as the site of the proposed Patterson reservoir site. Even should the water of the Patterson reservoir for the first few years taste slightly, it would not affect the drinking water of the city to any great extent, as the Patterson reservoir would be only one of 12 reservoirs serving the city. With their waters mixing, as they would, the slight taint from one reservoir would not be noticeable. Mason, the well known authority on water supply, states that water from swamp lands affects only those not accustomed to drinking it, and then only slightly.

It would be a wise investment, therefore, for the city of New York to build the Patterson reservoir.

Mr. Diven's conclusions, as well as those of other hydraulic engineers, make it apparent that the old theory that reservoirs should be stripped of vegetation is a theory no longer tenable.

A Contract Forfeited When the Eight-Hour Law Was Broken.

A legal opinion of interest to engineers and contractors was handed down by the Court of Appeals of the State of New York on Oct. 11, 1908. The case grew out of the construction of a sewer by the Williams Engineering & Contracting Co. for the city of New York in Bronx Borough. The comptroller of the city refused payment on the contract on the ground that the contract was forfeited because the contracting firm had worked its men more than eight hours and did not pay the prevailing rate of wages.

The case was tried in the lower courts and then taken to the highest court of the state. The opinion rendered by Judge Vann was the unanimous decision of all the judges constituting the court. Judge Vann, in his decision, says:

"The legislature now has the power and had when the present labor law was enacted to fix and regulate the hours of labor on public work by limiting them to eight hours in one calendar day. And to provide that when that limit is exceeded no officer of state or municipal government shall be permitted to pay therefor from funds under his official control. We do not uphold the labor law as constitutional to the limited extent that we pass upon it at all, because it is authorized by the police power which belongs to the state, for we can't see that it bears any reasonable relation to the public health, safety or morals. We uphold the statute simple because the people have so amended the constitution as to permit such legislation."

The leading German steel works, according to a recent Consular Report, are beginning to employ electric furnaces on an extensive scale for handling large quantities of metal. At one of these plants, which has been producing cast steel in an electric furnace of 250 H. P., holding a charge of a metric ton (2,205 lbs.), the total cost per metric ton, according to the Consular Report, has been as follows:

Cost.

Amortization of cost of plant.....	\$1.19
Raw materials, including additions, chromium, etc.	16.66
Electric current, including heating during intervals	10.71
Renewal of magnesite lining.....	2.85
Labor	2.38
Electrodes	.60
Water for cooling purposes.....	.12

Total\$34.51
This amounts to \$31.32 per short ton.

Bids are now being asked by the State Superintendent of Public Works of New York, for five contracts for work on the Barge Canal. The estimated cost of the five contracts is nearly \$7,000,000.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Method and Cost of Constructing Wooden Form for Concrete Manholes.

BY P. W. ENGLAND.*

Among the recent uses to which concrete in its ever widening range of utility is being put, may be mentioned manholes for underground conduit construction. The concrete manhole possesses not only the



Fig. 1—Templets Set Up Ready for Side Boards.

advantage of cheapness over the brick manhole, but it is more durable and can be constructed in considerably less time.

The accompanying photographs show a simple type of wooden form, which has been used with satisfactory results for building concrete manholes. It is designed for a barrel-shaped hole, 4 ft. x 6 ft. in

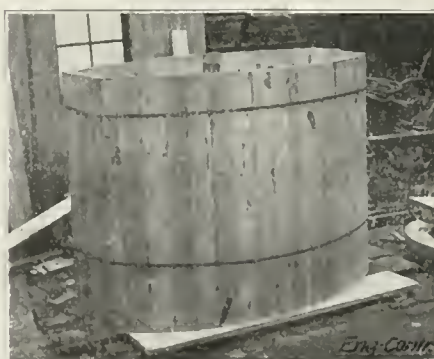


Fig. 2—Side Boards in Position.

size, with 5 ft. head-room under the roof, but the same general type can be used for any shape manhole.

Figure 1 shows the three "templets" in place, supported on so-called "ladders" at either end. Each templet is made in four pieces, two side pieces and two end pieces,

*1633 Arch St., Philadelphia, Pa.

of 1½-in. yellow pine, the end pieces being secured to the side pieces by ½x3½-in. bolts with wing nuts. The bolts are intended merely to hold the four templet pieces rigidly together and not to take the

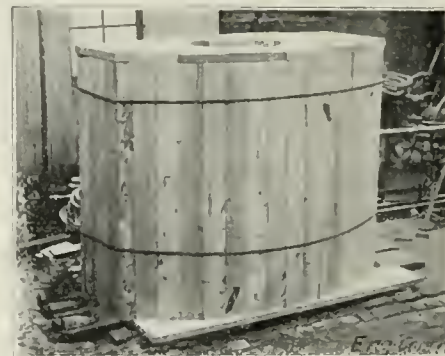


Fig. 3—Top in Place.

end and side thrusts, which are provided for by cleats or shoulders on the templets. As the manhole is constructed complete at one time, including the roof, the form is designed so as to be readily "knocked down" and passed out through the circular opening in the roof, 2 ft. 6 ins. in diameter.

Figure 2 shows the vertical side-boards in position. These are of 1x5-in. yellow pine, dressed on both sides, and are all interchangeable, with the exception of the corner pieces, which are beveled. Ropes hold the side-boards in place against the templets until the concrete is started, when they are removed.

In Fig. 3 the roof form is shown rest-



Fig. 4—"Neck" Piece in Place.

ing directly upon the side-boards which support it. It is made in four pieces, of 2-in. yellow pine. Cleats on the under side bear against the vertical side-boards and serve to centre the roof form. Two

wedges at the centre make it easy to "knock down" the roof.

The form of the circular opening in the roof (Fig. 4) is made in one piece, with sides of 1x2-in. strips, 8 ins. long, nailed to two circular frames at top and bottom, built up of 1-in. stuff. This "neck" piece is tapered $\frac{1}{2}$ in. on each side to permit of ready withdrawal upward.

The form complete weighs 650 lbs. Two men can set it up in $1\frac{1}{2}$ hours and can knock it down in about 1 hour. It costs as follows:

Lumber	\$19.00
Labor, carpenter at \$3 a day.....	12.00
	\$31.00

The manholes built with this form had 6-in. walls and an 8-in. roof, the latter reinforced with four $\frac{3}{4}$ -in. Kahn trussed bars, 5 ft. 6 ins. long. Portland cement concrete was used, mixed in the proportions 1 part cement, 2 parts sand, and 5 parts broken stone. Wherever the nature of the soil would permit the excavation was made exactly to size so as to serve as a back form for the concrete.

Method of Constructing Reinforced Concrete Highway Bridges in Ontario With Some Figures on Cost.

The bridges were built in the township of Sandwich South, Essex county, Ontario, in 1907, and were designed and their construction superintended by Mr. Owen McKay. Three of the bridges had plain slab floors and two had girder and slab floors, carried on concrete abutments. They were all single-span bridges for highway service and were built by contract according to specifications by Mr. McKay.

Specifications.—The abutments and wings shall be made of concrete masonry composed of 1 part of American or Canadian Portland cement of approved brand, 3 parts of clean, sharp sand, and 5 parts of crushed stone. Gravel may be substituted for crushed stone in abutments, at the discretion of the engineer.

The upper $1\frac{1}{2}$ ins. of floor shall consist of 1 part of Portland cement to 2 parts of clean, sharp sand, thoroughly mixed and applied before the remainder of the concrete in floor shall have time to set.

The concrete in the body of the floor and beams shall consist of 1 part of cement to 2 parts of sand and 4 parts of crushed stone.

All exposed places of the bridge shall have a coating of cement mortar 1 in. thick, composed of 1 part of Portland cement to 2 parts of clean, sharp sand, which will be applied at the same time as the backing, and the whole rammed while fresh to insure a perfect bond.

Molds for concrete shall be composed of 2-in. plank dressed on the inner side and

both edges to a uniform thickness, and shall be made stiff to prevent distortion during filling; molds must be left on the masonry as long as may be required by the engineer.

Before laying the steel reinforcement, the forms shall be covered with a layer of cement mortar, 1 part of cement to 3 parts of fine gravel, on which the steel shall be laid according to detailed drawings, after which the concrete shall be immediately deposited and thoroughly tamped around to form a perfect bond.

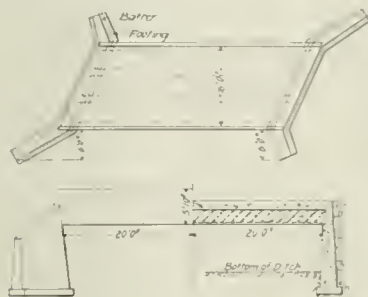


Fig. 1—Concrete Slab and Girder Highway Bridge, Essex County, Ontario.

The concrete shall be mixed in a medium wet condition.

The cement must be of the best quality of freshly ground brand of Portland cement, approved by the engineer.

Sand and gravel shall be clean, rather coarse, and free from vegetable mold or other hurtful matter, and shall be screened, if considered necessary, by the said engineer or inspector.

All broken stone must be made from clean, durable rock, and crushed so that it will pass through a 2-in. ring and be rejected by $\frac{3}{4}$ -in. ring where used in abutments and wings; but the stone in floor

between beams to provide against longitudinal strains.

This bridge, as well as the others referred to above, was designed to carry a 15-ton road roller, or 150 lb. live load, uniformly distributed over the entire surface.

The concrete in the lower part of the abutment was composed of 1 part of Portland cement to 6 parts of gravel. In the girders and floor, and 1 ft. beneath, it was made of 1 part Portland cement to $\frac{1}{2}$ part sand and 4 parts stone crushed to pass through a $\frac{3}{4}$ -in. ring, excepting the upper $1\frac{1}{2}$ in. of floor and exposed faces of beams

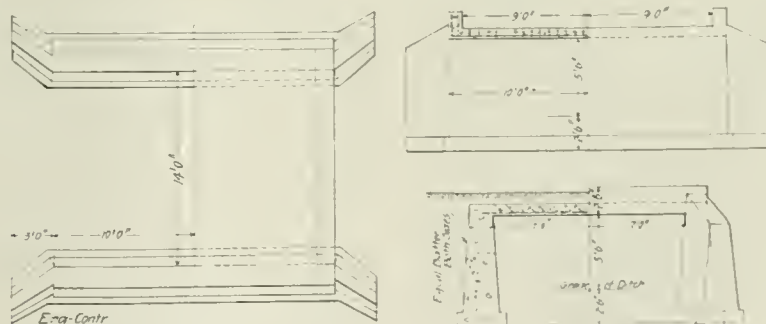


Fig. 2—Concrete Slab Highway Bridge, Essex County, Ontario.

and beams shall be broken to pass through a $\frac{3}{4}$ -in. ring. Within these limits the entire product of the crusher must be used.

Pike Creek Bridge.—This bridge had a clear span of 40 ft., with a width of roadway between railings of 16 ft. The two outside beams or girders are 18 ins. in width and 31 ins. in depth from bottom of girder to top of floor, but in the two outside girders the concrete was built up to the height of 3 ft. above the floor and 6 ins. in width, and suitably to form a railing. The two inside girders are 20x36 ins. The length of girders and reinforced steel

and girders, which were faced with cement mortar in the proportions of 1 part cement to 2 parts of clean, sharp sand. The concrete was mixed by a concrete mixer, the girders, railing and back filling between and behind the girders being all completed in one day, and the floor slabs on the following day, in order that the completed bridge should conform as nearly as possible to a monolith.

Two months after the bridge was completed it was tested by passing over it a threshing machine engine weighing 9 tons, coupled to a wagon carrying a water tank

*Rearranged from a paper by Mr. Owen McKay read before the Association of Ontario Land Surveyors.

weighing about 3 tons. This load passed over the bridge several times, with speeds increasing from about 2 miles to 7 miles per hour, but we could not detect the slightest deflection or vibration in the bridge, and the effect of the load was not noticeable in any way.

The cost of the bridge was as follows:

Item	Total.	Per Cu. Yd.
Abutments and wings—		
66.3 cu. yds.	\$596.70	\$9.00
Floor and railings—		
41.6 cu. yds.	374.10	9.00
7,113 lbs reinforcement		
at 3½ cts.	250.00	*6.00
Engineering, superintendence,		
etc.	95.00	0.88

*This cost refers only to the 41.6 cu. yds. in the slab and girders which were the only parts containing reinforcement.

The total cost of the bridge was \$1,316.10, which, divided by the total yardage of 107.9, gives a cost of \$12.18 per cubic yard. This cost includes excavation, forms, removal of old bridges, etc. The reinforced concrete in the girders and slab, it will be seen, cost something over \$15 per cubic yard.

Little River Bridge.—This bridge had a clear span of 20 ft. and a roadway 16 ft. wide between railings. It was constructed like the Pike Creek bridge except that the outside girders were 12x22 ins. and the inside girders were 16x24 ins. The railings consisted of an 8-in. coping and gas pipe. The cost of this bridge was as follows:

Item	Total.	Per Cu. Yd.
Abutments, 14 cu. yds.	\$330.00	\$7.50
Floor system, 15 cu. yds.	135.00	9.00
Coping and railing.	35.00	.80
Reinforcement	98.00	*6.53
Incidentals	70.00	1.59

Total. \$668.00 \$15.19

*This cost refers only to the 15 cu. yds. in the floor system.

Slab Culverts.—The three slab culverts were of essentially the same form. Figure 2 shows the culvert of 14 ft. span. The slab is 10 ins. thick at the center and 9 ins. at the sides; it is reinforced with ½x1½-in. Kahn bars, 16 ft. long, spaced 9 ins. on centers. For the 8 and 10 ft. culverts the slabs are 8 ins. thick at the center and 6 ins. thick at the sides. The costs of the culverts were:

14-ft. span	\$325.00
10-ft. span	267.50
8-ft. span	235.00

Maywood, a suburb of Chicago, Ill., has a number of cases of typhoid fever. In a recent analysis of the water in the mains disease germs were found, although that in the standpipes of the suburb is said to be pure. It is believed that a water main was broken at some point during the process of laying a sewer through the village, allowing germs to enter the pipes. On search a main was found that had been broken by the sewer-laying machine.

Record of Work of a 2-Cu. Yd. Concrete Mixer.

Concrete mixers of 2 cu. yds. batch capacity are so rarely built and used that the following statement from the manufacturers of the work being done by one of this size will certainly interest contractors. Incidentally this statement includes some general facts concerning the Government breakwater improvement at Milwaukee, Wis.:

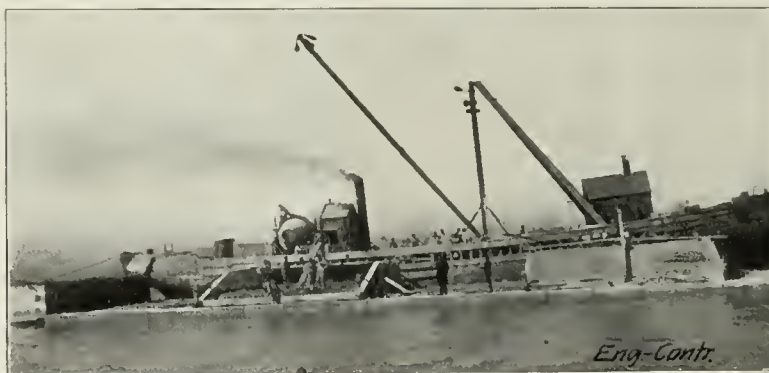
"A 2 cu. yd. mixer has been set up and is now in successful operation on the breakwater work at Milwaukee, Wis. The breakwater extends out into the lake in a south-easterly direction about 2,400 ft., and from that point south about 1 mile. There is a gap between the end of the breakwater, and the end of the north pier at the harbor entrance of about 4,200 ft. The piers at the harbor entrance are at right angles to the shore, and about 240 ft. apart. The distance between the end of the breakwater, and the piers at the harbor entrance, is being reduced by the extension of the breakwater for 980 ft.

Both the breakwater, and piers, as origi-

The mass concrete is also divided into two sections, approximately 25 ft. long. The sub-structure cribs are of two widths, 24 and 30 ft. The width of the superstructure is varied according to the size of the cribs below.

The blocks are molded on a wharf, 90x925 ft., located on the harbor side of the breakwater, not very far from shore. As the blocks measure 6¼x8 ft. at the base, and 3½ ft. in height, and weigh about 13 tons, hauling them from the wharf to position in the breakwater, and placing them, is a matter requiring special attention. To facilitate handling, four 1-in. eye bolts are placed at the top of each block as it is cast, one bolt toward each corner. The blocks can thus be picked up, by means of chains, by a derrick mounted on a scow.

After a section of the crib has been prepared for the reception of concrete, blocks sufficient to extend the breakwater about 50 ft., on both sides of the crib, are carried out on the scow, and set in place. The space between the two rows of blocks is filled, within 6 ins. of the datum plane, with stone; and the voids in this stone are in



Mixer Plant for Milwaukee Breakwater Work.

inally constructed, consisted of timber cribs, filled with stone, extending about 5 ft. above the water line, and flooded over. Owing to the wearing away of these piers, the Government is cutting away the timber cribs at a point about 3 ft. below the water level, replacing the part removed by a concrete superstructure, the work being done from time to time as funds became available for the purpose. The first work attempted along this line was on the north entrance pier, which has been completed. The superstructure on the breakwater is just being completed. As hereinbefore mentioned, the Government is extending the breakwater for a distance of 980 ft., using the original crib construction, it being the intention, in due time, to place thereon a concrete superstructure.

The type of construction adopted consists of concrete in place, molded in forms, and founded on two longitudinal rows of concrete blocks, and in certain places also on cross walls between these rows of blocks. The upper surface of the block is 6 ins. above datum, while the upper surface of the mass concrete is 5½ ft. above datum.

turn filled with gravel. The 25 ft. sections of mass concrete are cast alternately. The concrete is placed continuously in each section so as to be monolithic. Sections are built so as to span the intervals of the crib sub-structure. In each section spanning an interval, and in other sections where necessary, steel reinforcing bars are used.

Floating equipment is necessarily used in placing blocks in position. Of course, work of this nature can only be done during quiet weather. In order to make the best use of quiet intervals, this floating equipment must be capable of delivering large quantities of concrete in short periods, and of being towed quickly to shelter in case of storm. In order to meet these conditions, a 2 cu. yd. "Smith" Mixer built by the T. L. Smith Co., Milwaukee, Wis., has been mounted on the deck of an old steamer, with a batch feeding hopper over it. Sand and stone are delivered in scows, from which they are delivered to the mixer in scoops by a stiff leg derrick. The cement is stored on the mixer board; and is delivered to the mixer by hand. A stiff leg derrick also takes the concrete from the

mixer, and places it in the breakwater forms.

With a plant arranged in the manner above described, two of the 25 ft. sections of the mass concrete containing 97 cu. yds. each, or a total of 194 cu. yds., have been placed regularly in 7½ hours, with a force of 20 men. Probably, if materials could be delivered more quickly, as would be possible on land, even this large output could be improved.

Forms are used for the two ends of the higher side of each alternate sections of the mass concrete. Intermediate sections are cast without forms.

Up to 3½ in. below the line of the finished upper surface, ordinary 1-3-6 concrete is used. While this concrete is still fresh, 3 ins. of 1-2-5 concrete is laid thereon. This 3-in. layer is carefully tamped to secure a perfect bond with the underlying concrete. A ½-in. layer of 1-2 mortar is then laid over the fresh concrete, and is finished like the surface of a concrete sidewalk. Forms are left in place 24 hours; and, after they are removed, concrete is kept wet and protected from the sun for ten days.

These improvements are being carried on under the direction of Col. W. D. Judson, Corps of Engineers, U. S. A., Engineer of River and Harbor Improvements on the West Shore of Lake Michigan, North of Chicago.

With the exception of the 980 ft. extension of the breakwater, the work has all been done under contract by Mr. Wm. H. Gillen, General Contractor, Milwaukee, Wis."

The contract for the erection of the new passenger depot of the Chicago & Northwestern Ry. Co. on West Madison St., Chicago, Ill., has been let to the George A. Fuller Co., of Chicago and New York. The contract comprehends the expenditure of approximately \$5,000,000 and stipulates that the new depot shall be completed within two years from the time work is begun. The station is to cover, with the train shed, ten acres of floor space, which will be devoted to the public use. Its total cost, inclusive of the cost of the ground upon which it will stand, will approximate \$20,000,000. The station is to be of classic design, the essential feature of which will be a great colonnaded entrance or portico of monumental appearance, 120 feet in height. The arrangement of the ground floor will be such that it will be possible to handle 30,000 suburban passengers in and out of the station without their coming in contact with through passengers. The train shed will be 840 ft. long and 320 ft. wide and will contain 16 tracks, each with a capacity of 15 cars.

The Delaware, Lackawanna & Western Ry. will soon have 400 miles of its lines equipped for train dispatching by telephone.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Stripping Reservoir Lands.*

BY J. M. DIVEN.

As there has been some controversy lately as to whether or not it is an advantage to "strip land" for reservoir purposes, the writer thought that possibly his own personal experiences with rather notable examples of each class might be of some interest and, better, bring out some discussion on this important question.

The first experience was with a "strip-ped" reservoir, at Elmira, N. Y. This reservoir was built in 1871 and 1872, and was filled in the fall of 1872.

The drainage area is 4½ sq. miles, all hilly and sparsely inhabited farm land. A small portion only is under cultivation, most of the land being pasture or wood land. The soil is clay or heavy clay loam, the rock formation a shaley slate. The land is all hilly and contains numerous ravines with steep sides.

The reservoir is formed by an earth dam across a narrow ravine, in which a small creek flows, or rather used to flow, as the wholesale cutting of the timber on the water shed has made it a flooded creek in the rainy season, and a dry creek bed in dry seasons.

The dam was designed by Mr. A. Fetyel and is of earth, with a clay-puddle core wall. The outer slope is 1½ to 1, sodded inner slope 2 to 1, riprapped with rough "field stone," gathered mostly from the reservoir site during the construction. The dam is 700 ft. long on top and 36 ft. high at center, or over the old stream bed; the overflow is 33 ft. above the bed of the stream, and is constructed in the hill at the end of the dam. There is a storm-water canal the entire length of the reservoir, and the inlet is controlled by suitable headgates. The flood water or first wash of the drainage area during heavy rains and floods is carried around in this canal. The reservoir covers thirty-eight acres and holds 113,000,000 gallons.

All of the top soil of the area to be flooded was stripped off and used for the lower slope of the dam, and much of the material for the dam was taken from this area, so that most of the reservoir site was excavated to a considerable depth. The land was then thoroughly grubbed; all roots of trees and underbrush being carefully removed. This left a clean, new soil, free from all vegetable growth. This bottom soil is a heavy clay or hard pan mostly, the shale rock being exposed over a small por-

tion. The sides were not riprapped, except on the face of the dam.

The outlet pipe or supply to the city is 16 ins. diameter, the inner end fitted with a swivel joint and the stand pipe controlled by floats, so that water is drawn at any desired depth. There is also a 20-in. waste pipe under the dam. This reservoir yields about 1½ million gallons per day and was the only supply for the city at that time.

As stated, above this reservoir was first filled in the fall of 1872. During the winter of 1875 and 1876, an extremely cold winter, when the reservoir was covered with ice nearly two feet thick, a pronounced odor and taste was noticed in the water. This was variously described as musty, fishy and cucumber. The trouble was not serious and soon passed away.

At that time little was known about the growths that imparted these disagreeable odors and tastes to water. It is doubtful if even the general name of algae had been applied to them; certainly we could not then pick out any name the particular organism that gave the various odors and tastes. It was even some years after this—in 1891—when this association appointed a committee, headed by the late Alfred Leeds and having as its other members, Col. L. H. Gardner of New Orleans and L. J. LeConte, Oakland, Cal., to investigate vegetable and animal growths affecting water supplies.

The trouble of 1875-6 was attributed to the wood pipes, of which the distribution system then consisted, a considerable amount of new pipe having been laid in the summer of 1875.

After the trouble of the winter of 1875-6, no further trouble was experienced for several years, when in the summer of 1883 or 1884, it returned and in a very much worse form, so bad that it was necessary to abandon, temporarily, this gravity supply, though the reservoir was nearly full, a pumping plant having been erected on the Chemung river, a stream with a large drainage area and a minimum flow of about 110,000,000 gallons per 24 hours. This trouble also disappeared in time, but reoccurred, with more or less intensity every year thereafter, apparently gradually growing worse and the trouble periods longer.

In 1896 a Jewel high type gravity filter was installed but this would not entirely remove the odors and tastes. At times the water from this reservoir was so bad that it could not be filtered. It would clog the filter beds in a few minutes and left a sticky, disagreeable, gelatinous coating on the sides of the tanks. The odor when the

*A paper delivered before the American Water Works Association.

filters were washed was at times very disagreeable, indeed, almost unbearable. It has been so bad in the reservoir that it was disagreeable, if not even nauseating, to stand on the banks with the wind blowing towards one over the water.

This, of course, made it necessary to abandon the supply until the trouble passed, that is, until the water had purged itself and the dead algae had settled to the bottom. Every known expedient was tried; the mains were thoroughly and frequently flushed, but without success. Water was drawn from the surface, the outlet screen-head being at times lifted partly out of the water, so that considerable air was drawn into the supply pipe with the water; we did not know that anaboea was the cause of the trouble and that it stayed near the surface—various depths, to the very bottom of the reservoir were tried, but with no good results.

And, here, a word more about aeration. Before the introduction of the filters the water from this reservoir flowed to a distributing reservoir, the surface of which was 110 ft. below the base of the dam. It entered this reservoir through a fountain having a 4 in. center jet and 132 $\frac{1}{8}$ in. side jets, the pipe between the reservoir was 12 ins. diameter, cement lined, wrought iron. In still weather the center jet threw a stream over 70 ft. high, which falling, pounded the surface of the water into a foam, undoubtedly adding large quantities of oxygen to the water. The side jets threw streams at an angle of about 25 degrees, which fell near the edges of the reservoir, so that the entire surface was constantly agitated.

During one of the outbreaks of algae, the writer made a 1½-in. tap in the top of the outlet from the distributing reservoir, a few feet from the outlet chamber, and run an open pipe to a height of a few inches above the surface of the water in the reservoir, which was quite constant, the inlet being controlled by float valves, hoping that the outflow current would suck air into the supply main to the city. Some air was drawn in, how much is doubtful, anyhow it was not enough to do any good.

In 1904, when algae was very bad in the storage reservoir, it was treated under the direction of Mr. James M. Caird, with copper sulphate, and the treatment was entirely successful. The treated water was filtered without difficulty and supplied to the city in good condition, free from all odor and taste. This treatment lasted about two years, when it was necessary to retreat the water.

Asterionella and anaboea were the principal organisms that caused the trouble.

The second experience is at Charleston, S. C., where the conditions are an exact opposite.

The reservoir at Charleston was built in 1904-5, and was first filled in the spring of 1906.

The drainage area is 19½ square miles,

all flat land and much of it swamp. The population on the drainage area is small, there being no towns. The soil, that is not swamp, is either sand or red clay, containing considerable iron and black muck. A part of the flooded part was salt marsh, subject to tidal overflows. The reservoir was formed by a low earth dam across the creek and about half mile of salt marsh. The land is flat, no elevation on entire water shed being more than 40 ft. above mean low tide, and the water is backed up for about 8 miles. The reservoir covers about 2,300 acres, when full; the land was salt marsh, swamp, old rice fields and high ground, mostly grown up to second growth, loblolly pine. The capacity of the reservoir is 3,127,820,000 gallons. The spillway is 10½ ft. above mean tide and the dam was built as much to dam out the tide water as for storage. As will be seen from the above description, the reservoir is mostly very shallow. The original stream which was narrow and winding, had a considerable depth, but the flooded ground is covered to an average depth of less than four feet. The contour lines are very irregular, many small swampy places, side gulches being overflowed.

No attempt was made to clear, clean or "strip" this land before flooding, except burning the grasses in part, and even this was not done over all the surface, and for the most part they had time to grow up again before the land was covered with water. Even the standing timber was left and was, except cypress, of course, killed. This timber, much of it large pines and undergrowth, which was in places, dense, had died out and fallen into the water. The fresh water killed all of the grasses on the salt marsh, and fresh water grasses took their place.

When first flooded, there was little clean space free from timber, underbrush or coarse grasses, except where the stream originally flowed, and some old rice fields, which were flooded to a sufficient depth to hide the grasses. But, gradually the water surface has cleared up, the grasses and underbrush have disappeared entirely and the trees are little more than the bare trunks, where they are standing, stripped of their bark, with the exception of cypress which flourishes in water. The higher marshes that were covered with grasses or rushes have broken away from the shores and floated down to the dam, where they have been cut up and thrown over. Large sections of the old rice fields have come to the surface, forming floating islands, some of them several acres in extent and stable enough to walk on. These are bare when they come to the surface, but a rank growth of sedge grass soon covers them. They are composed of a mass of the roots of these coarse grasses, and alluvial black mud, or decayed vegetable matter. They are from eighteen to thirty-six inches thick. They are cut up into blocks of a convenient size with saws, very much as ice is cut and

skidded over the dam, to which they are carried by the current and the prevailing winds. When dry, they burn quite freely, they also make an excellent fertilizer. There is in the more shallow places a luxuriant growth of "Water Verbena"; lemna also, covers a good deal of the water in summer.

Shortly after the reservoir was filled, during the first season, algae appeared in troublesome quantities; crenothrix appearing first and giving the most trouble. The water contained 3.5 parts per million of iron. Anaboea, osciliaria and some others of the taste and order, imparting algae, were present in large quantities. An aerating plant was put in to get rid of the crenothrix, and copper sulphate was used freely, about six tons being used this first year, the consumption being 3,500,000 gallons per day. By these means the situation was satisfactorily handled and the water kept good.

The second year the trouble was much less, it disappeared entirely during the winter, though there was always some crenothrix present in the raw water. About 2½ tons of copper sulphate was used the second season, and less than 1½ the third, indicating that the growths of algae are gradually lessening.

The summers are long, about nine months, but there are some sharp frosts during January and February—the conditions not being tropical. The conditions, are however, ideal for algae growths, but they are gradually improving and it is hoped that in a few years this water will be no more subject to these growths than any other impounded water; this hope is based on data obtained from numerous smaller but similar reservoirs in the vicinity. Many were built years ago as "rice reserves to store water for flooding rice fields. These were originally flooded exactly as the Charleston Water Works reservoir was, but are now clear ponds, the water having very little color, much less than in the water works reservoir. The vegetable growths about the edges of these ponds are entirely different from the original growth, the water is good to look at and is palatable.

The Elmira reservoir was as thoroughly stripped as possible; great care was taken to keep out the first washing from the drainage area and the muddy flood waters. There was little or no marsh land on the drainage area, the catchment area being seemingly ideal. The reservoir was clean and clear; on the sides the slopes were abrupt and there was very little shallow water.

At Charleston the drainage area was largely swamp, and there was much decaying vegetable matter on all of the area drained, the water being decidedly peaty. The reservoir covered a large surface, was shallow, and absolutely unstripped or even cleared. Much of the land flooded was

composed of black muck or decayed vegetable matter.

In the first the conditions were at the first satisfactory and the water good for several years. But the trouble from algae growth came in time and has steadily grown worse, in spite of strenuous efforts to remedy the condition.

The second was troublesome and unsatisfactory from the first, but has somewhat improved and promises to continue to improve.

The writer's experience and information covers over thirty years, in the case of the Elmira plant. The Charleston plant has only been in use about three years, so that the future has much to develop.

This is written not so much for the information that it gives as in the hope that it will bring out some discussion by members who have had wider experiences and who have made a more scientific study of the matter.

Cost of Digging a Well or Cess Pool.

Circular wells or holes are often dug for water supply and for cesspools around buildings. The railroad engineer frequently has such holes to dig in connection with a water supply or for the sanitation of station buildings. For these reasons the following example may prove of interest.

The hole was dug on Long Island in a clay material with an occasional boulder. The material was stiff enough to stand up without shoring. The hole was 8 ft. in diameter and 24 ft. deep. For two days two men did the work, but, when a bucket had to be used, another man was added to the force. A three-legged derrick, with a crank on it, was used to hoist the bucket of earth. The excavation was made entirely with picks and shovels. There were 1,305 cu. ft. of material excavated, or about 48 cu. yds. A ten-hour day was worked. The cost of the work was as follows:

2 men 2 days at \$1.50.....	\$ 6.00
3 men 5 days at 1.50.....	22.50

Total.....\$28.50

This gives a cost of 60 cts. per cu. yd. for excavating and hoisting the material and dumping it on the ground by the side of the hole. This cost is quite reasonable for this work.

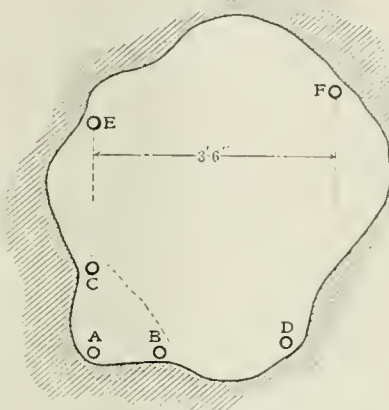
A new educational experiment is to be tried in the instruction of British miners by the Staffordshire county council at Hamstead, England. The purpose of this school is to furnish opportunity to miners to acquire scientific and other training in connection with mining, which will prepare them for higher positions in mines, for which they are unfitted, because of the lack of scientific and higher education. While this school is intended especially for miners, workmen in other industries will be afforded opportunity to attend.

Method and Cost of Sinking a Winze With Long Holes.*

BY GEORGE C. M'FARLANE,†

Last spring I had occasion to sink a winze in a hurry so as to make an air connection with a railroad tunnel. I had driven this tunnel from the east side of the ridge and was within about a hundred feet of coming out into the long approach on the west side when warmer weather made the natural air circulation too sluggish to carry out the powder smoke. I had already sunk several feet with hand steel, when I decided to continue the work with long holes.

The material to be sunk through was a rather hard red granite. I used a donkey boiler to furnish steam to drill the first hole, and when this hole broke through into the heading of the tunnel I ran a hose down the hole and connected with the pipe-line in the tunnel. Five more holes were now drilled, arranged as shown in the accompanying sketch. All the holes were about 30 ft. deep; they



Cross Section of Winze, Showing Arrangements of the Hole.

were started with a 2¾-in. and finished with a 1¼-in. bit. It took 4½ shifts to drill the six holes with a 3¼-in. Rand drill.

The holes were finished at midnight Saturday and three men began the blasting at 3 a. m. Sunday. Starting at the bottom, they continued to blast holes A, B and C. By noon they had a small hole through to the surface, and the winze was blasted to its full size by 4 a. m. Sunday.

The method of blasting was as follows: One of the men in the tunnel heading held a rag in the bottom of hole A with a tamping stick, while the men on top rammed in a foot of clay. One foot of dynamite was then tamped down; no tamping was placed on top and the charge was detonated with a drop fuse. This procedure was continued with the three holes in rotation. Every blast broke from 6 to 12 in. of ground. After the first couple of rounds it was not necessary to plug the

bottom of the holes, because when one hole was blasted it would close up the bottoms of the two adjacent holes.

When the blasting of the three holes was completed, an irregular, three-cornered hole was made about a foot in diameter and reaching from the tunnel to the surface. Holes D and E were then blasted alternately, about 6 ft. of the hole being loaded for a shot. Finally hole F was loaded from top to bottom and fired. This completed the winze.

The total time required was six shifts for the 30 ft. or 5 ft. per shift. The cost was as follows:

Drilling:

1 driller, 4½ da., @ \$1.00.....	\$ 18.00
1 helper, 4½ da., @ \$2.50.....	11.25
1 nipper, 1½ da., @ \$2.00.....	9.00
Steel shafting, four, etc.....	13.50

Blasting:

1 foreman, 1½ da., @ \$1.00.....	6.00
2 helpers, 1½ da., @ \$2.00.....	6.00
5 boxes, 60% dynamite.....	45.00
Box caps, 100 ft. fuse.....	2.00

Total\$110.75

This makes the total cost of sinking the 30 ft. \$110.75, or \$3.70 per foot. No particular pains were taken to plumb the drill in starting the holes and they did not vary over 5 in. from being parallel throughout. It takes three times the quantity of powder to break the ground with this long-hole method, but in this instance it was three times as cheap as hand sinking for the part of the winze sunk by hand cost more than \$9 per foot for labor and powder.

According to a recent Consular Report, water power is used to a considerable extent in Switzerland for the operation of factories. According to the factory statistics of 1901, the latest obtainable water power was used by 2,058 factories, with 185,486 H. P., against 1,471 factories, with 84,030 H. P. steam, and 1,213 factories, with 37,413 H. P. electricity. Since these figures were published, however, numerous changes and increases have occurred. Of the factories run by water power, 35,979 H. P. was devoted to the textile industry (27,782 thereof to cotton, and the remainder to silk, woolen, and linen mills and embroidery factories), 101,243 to the chemical and chemical-physical industry, 14,876 to foods and food-product industry, 8,320 to the paper and printing trades, and a few thousand each to brick, cement, and tile industry, woods, metals, watches, and jewelry and machine branches. Most of the steam power was used in the textile (28,000), foods (13,000), chemical (12,000), bricks, cement, tiles (8,000), and machine (7,500) branches. Aside from the foregoing there were 1,543 factories that did not possess their own motors.

Work on the high pressure water system for the business section of Chicago will probably be started next spring.

*Reprinted from "Engineering and Mining Journal."

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Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Specifications and Notes on Macadam Road Construction.*

Before we pass to the detailed consideration of our subject, a word should be said regarding the influence of modern traffic conditions on the methods of road building. In situations where but a few years ago there would be no doubt as to the efficiency and advisability of ordinary macadam construction, there is to-day much uncertainty in the minds of most highway engineers as to what is best. This change has been brought about by the increase in motor vehicle traffic, and has attracted the world-wide attention and study of road builders.

There does not seem to be any question but that it is impossible to maintain in good condition an ordinary macadam road subjected to any large amount of motor traffic. It is only by applying some tough, elastic binder in the top or wearing course of the road that a macadam surface can successfully resist this traffic. The present practice is generally to use for this purpose either a coal tar or an asphalt compound. Sufficient experience, however, has not been had to determine definitely what will prove best. Although considerable knowledge has been gained in the methods of application, the test of time is yet to prove the relative worth of different methods and material. The problem for solution is, can macadam roads that will prove satisfactory and economical under the new traffic conditions be built with only a slight increase in cost? If it is necessary for the preservation of macadam construction to double or treble its cost, we have other kinds of pavement available which are known to be more durable and, if economy is the chief consideration, to be more desirable.

There are, however, many miles of road that can be maintained as macadam roads. It also seems probable that where there is but a moderate amount of motor traffic such roads can be maintained by a comparatively inexpensive treatment which will insure a durable road surface at an expense not incommensurate with the worth of the road to the public. But we should keep in mind that even though our road to-day has but little or no motor traffic, it probably will have more, rather than less, so that our method of construction, wherever we can do so economically, should be changed to meet such a condi-

tion. The specifications and suggestions made here have been drawn with this idea in view.

Thickness of Macadam.

The thickness of macadam to be used at any particular point shall be that as shown on the plans or as indicated in writing by the engineer. In general, there shall be three classes of macadam, known as 6-in., 8-in. and 10-in. construction. The thickness in each instance is to be that of the road after thoroughly compacting by rolling and completed in accordance with the specifications herein contained. The thickness, after rolling, of the various courses in each class is to be as follows:

Class	1st Course	2nd Course	3rd Course
6-in.	4-in.	2-in.	To be as
8-in.	5-in.	3-in.	hereinafter
10-in.	6-in.	4-in.	described

Each course of broken stone is to be applied as herein specified.

Note: The chief factor governing the thickness for a macadam road is the nature of the soil in the roadbed. Where the soil does not change it would not be necessary to indicate more than one thickness. Otherwise, a careful examination of the roads is necessary, and the thickness determined for each section should be indicated on the plan. Experience has demonstrated that a thickness from 8 to 10 ins. is ample under any condition where a road can be maintained. If this thickness does not prove sufficient, it is evidence of an improper foundation, and the remedy must be sought there. The usual trouble is lack of proper under drainage. Where this is provided there need not be any excessive thickness of road covering. It has been the writer's practice on clay and other retentive soils to make about an 8-in. road; that is, the stone is spread in two layers of about 5 ins. each, which after rolling reduces to about 8 or 8½ ins. in thickness. On sandy soils, or soils containing a considerable percentage of sand, which are more or less porous, and where there is perfect under drainage, 6 ins. of macadam has been found to be ample; the 6 ins. being the thickness after the necessary rolling. It would require about 8 to 8½ ins. of road material. The nature of the material also affects to some extent the amount of material that would be placed for road covering. Where soft limestone has to be used and the wear is consequently faster, it is better to provide an extra thickness of material.

First Course for Macadam Construction.

Macadam construction is to be used wherever directed by the engineer or provided for in the plans. The width required at different points is to be that shown on the plans.

The first course of macadam construction is to consist of sound stone broken to sizes varying from ¾ in. to 1½ ins., no piece to have a diameter greater than 1½ ins.

No material is to be used which, in the opinion of the engineer, is unfit for the work. If any such material is put upon the road it shall be removed immediately upon notice from the engineer, and replaced by proper material at the contractor's expense.

Note: It is not necessary that the first or lower course of a macadam road should be of the hardest or toughest material. The purpose of the lower course is to distribute the weight of the traffic over the earth foundation, so that wherever it happens that tough material suitable for a good wearing course is remote from the place of construction, and consequently higher in price than more accessible material which is not so good, economy can be effected by using the poorer local material in the foundation course, applying the better material to the upper course only. A quality of gravel that would not make a good road surface may be used in the first course; likewise burned shale; in fact, any comparatively non-absorbent, enduring material broken to a suitable size.

Spreading.

No broken stone is to be spread before the roadbed has been made as specified.

The broken stone is to be spread upon the roadbed, prepared as herein described, with shovels, from piles alongside the road or from a dumping board, or it may be spread directly from wagons specially constructed for this purpose and approved by the engineer; but in no case shall the broken stone be dumped directly upon the roadbed.

As soon as spread, the layer of stone is to be thoroughly raked or harrowed with a tooth harrow, and finally trimmed true to the shape of the cross-section.

Note: It is a well known fact that a mass of various sized pieces of stone adjusts itself when stirred or raked so that the smallest sized particles are at the bottom and the largest at the top. When this condition is attained, we have what may be called a stable equilibrium of the particles relative to one another.

Therefore, if we rake thoroughly a layer of stone, we shall adjust the pieces so as best to resist any disturbing force. As the roller goes over a layer of material thus assorted it tends to compact much more readily, as the larger pieces do not attempt to work their way through the road surface. The arrangement often seen represented in cross sections, showing the largest pieces at the bottom and the smallest on top, is a reversal of what it should be. The stability of such a mass of material may be compared to that of a pyramid resting on its apex.

It will be readily appreciated that if the pieces of rock forming a road surface have been well compacted, even though the smaller pieces are at the top, there will not be any relative movement of the pieces of stone except that they are loosened, which will happen when frost is coming out of a badly drained road. Where such places are encountered, and there are many instances of roads practically impossible to drain properly, the road surface can be maintained much more nearly intact, if the pieces of stone are arranged with the smallest at the bottom.

But it is not sufficient merely to have a layer of the smaller screened stones as a bottom course and a layer of larger size on top. In the smaller size are pieces varying from ¾ to 1½ or 2 in., according to the size of the screen. It is then de-

*Abstract of a paper by Mr. A. N. Johnson, State Highway Engineer of Illinois, read before the Western Society of Engineers on Oct. 21.

sirable that as nearly as possible all of the 2-in.-size be at the top and the other sizes arranged in this order down to the smallest. This arrangement can be effected sufficient for all practical purposes by thoroughly raking or harrowing the layer of stone after it is spread.

There is another object attained by this method which has always been recognized as most desirable in the construction of macadam roads, and this is to have the surface composed of as nearly equal sized pieces as possible. As a macadam road surface composed of various sized pieces begins to show wear, it is observed that the largest pieces of rock protrude, producing a rough surface.

The fact that the larger the pieces of rock, the more resistant is the road surface to the action of traffic, is another reason for having the larger pieces at the surface. There is, however, a practical limit to the size of the pieces of rock for macadam construction, varying somewhat according to the hardness of the rock and character of the traffic. The soft limestones can be screened through a 3½-in. screen and used successfully for the surface. Many hard rocks, as trap and some granite, cannot be used so large, a 2½-in. screen being the largest, unless subjected to very heavy traffic; that is, traffic made up of heavily loaded wagons.

It has also been observed that a road surface composed of small pieces of stone deteriorates much more rapidly under action of automobile traffic than when built of larger sizes. While the writer cannot offer exhaustive evidence on this point, all of his observation confirms this opinion.

To sum up what is gained by using the smaller pieces of rock in a layer at the bottom and the largest at the top, we have a more stable road, a more even, and a more durable surface.

Rolling.

After the broken stone for the first course has been spread and raked or harrowed to a uniform thickness, and has a proper cross-section, it is to be rolled with a steam roller, weighing not less than 10 tons, until it is compacted to form a firm, smooth surface. The rolling must begin at the sides and work towards the center and the rear wheels of the roller must cover this space thoroughly.

Note: The strength of a stone or macadam road depends entirely upon the rigidity with which one piece of stone is held against its neighbors. The roller presses the piece of stone close together so that instead of having a contact of but one point or one edge with a face, the faces of the pieces of stone are brought together and the voids as they exist in the loose material are reduced from 45 per cent or 50 per cent to about 20 per cent.

It is bad practice to fill in the voids in the stone with fine material before rolling, as it prevents the pieces of stone being keyed firmly in place. There does not appear to be any valid reason for filling or bonding the lower course of material at all, and is so much work wasted. A roller should be run slowly, not over two miles

an hour. The slower the roller is run, the more firmly are the stones compacted. It is possible to run a roller so as to tear a layer of stones to pieces.

Unevenness or depressions.

Should any unevenness or depressions appear during or after the rolling of the first course, they are to be filled immediately with broken stone and re-rolled until a firm, even surface is obtained.

Note: A depression in a layer of macadam should be filled with material of the same kind and size as that composing the layer. If a patch of small material should be added to bring up the surface composed of large pieces, the small pieces would be ground under traffic, and the depression would again appear. The proper way is to loosen the surface in the depression, add extra material of the same size, and re-roll.

Thickness.

The thickness of the first course of broken stone, after thorough rolling, is to be that of the class of macadam construction specified for any particular place as described.

If, for any reason, a greater thickness than specified is made by the contractor, no extra allowance for such additional thickness will be made.

Shoulders.

After the telford foundation or the first course of broken stone or gravel, as the case may be, has been made as herein described, earth shoulders are to be constructed along each side of the road for a width of at least four feet, as shown on the accompanying plans.

Against these shoulders is to be spread the broken stone for the second course as herein described. The shoulders are to contain a sufficient quantity of earth so that a smooth and continuous slope will be obtained after the shoulders and second course are rolled. The shoulders with the feet of stone will make a total width of feet to be shaped with a cross-slope of inches..... to 1 foot.

Material for the shoulders must be free from roots, stumps or other vegetable matter and thoroughly compacted by the roller. Material with such a proportion of sand, as prevents it, when dry, from compacting readily under the roller, is not to be used.

No material which is considered unfit for the work by the engineer is to be used, and, where any such is put on the work it shall be immediately removed, at the contractor's expense, upon notice by the engineer.

Note: It is important to have the material for the shoulders put in place as soon as the first course is made, as the shoulders are depended upon to hold the second course of material in place. The shoulders should be shaped before they are rolled, so that they will be, depending on the motion of the material, from 2 to 3 in. higher than the second course of broken stone. As the work progresses, the height that it is necessary to keep the shoulders above the broken stone so that they will roll down properly, is very readily ascertained. If it is found that not enough material has been used, more must be spread until the shoulders are brought to a proper shape. If the road bed for the new road has been cut sufficiently deep, it will not be necessary to fill in extra material for the shoulders. Where the shoulders are thus made, by cutting out, it is advisable to leave them a little high at first, and then pare them down with a road machine. After a little experience a good operator can trim the shoulders very accurately by this method.

An excellent plan is to sow the should-

ers with grass seed. The sod forms a good protection to the shoulders, besides adding much to the appearance of the road.

Blind Cross Drains.

Blind cross drains are to be constructed at intervals of 50 ft. on each side of the road in the following manner: They shall run approximately at right angles to the direction of the road and shall be cut to a sufficient depth so that the water can readily run from the surface of the subgrade to the side of the road. They shall not be less than 8 ins. in width. These drains are to be shaped just before spreading the first course of material and are to be filled with broken stone. These cross drains are to extend to the gutter. The stone in the cross drains shall come within 3 ins. of the finished surface of the shoulder.

Note: The blind cross drains are necessary wherever the shoulders are made of an impervious material. These cross drains are particularly useful on level stretches of the road where satisfactory longitudinal drainage is difficult to secure. Roads constructed through lowlands, which may be submerged by occasional floods, should be well provided with these blind side drains. In such instances they should be put in at intervals of about 30 ft. The pitch or grade to these drains should be the most that can be obtained from the surface of the subgrade to the bottom of the gutter. They also serve to keep the shoulder well drained, and consequently firmer in wet weather. The side drains are especially useful during construction to drain the roadbed rapidly after a rain, which easily penetrates the loosely spread material, and softens the subgrade so that work has to be abandoned on that section until it dries out.

Second Course for Macadam Construction.

The second course of the macadam construction is to be the same width as the first course.

The second course is to consist of stone broken to sizes varying from 1½ to 3 ins.; no piece to have a greater diameter than 3 ins.

Unless otherwise specified, the rock shall have a "coefficient of wear," as determined by Duval test, of not less than 15.

Note: It should be borne in mind that the second course, or the course covering the foundation of either macadam or telford construction, is the one which must receive the wear from the traffic. The foundation course merely gives the thickness so that the pressure of traffic may be distributed over the natural earth roadbed, which supports the road surface. Therefore, in making specifications for the second course of material, its purpose should be kept constantly in mind. Inasmuch as the wear due to the traffic is dependent on so many different conditions, it will be natural to expect that which is best in one instance may not prove equally successful in other cases.

The wear due to traffic is of two kinds: That of horses' hoofs, and that from the grinding of wheels. These produce different effects on the broken stone roads. Where the traffic is very heavy, that is, where the weight upon the wheels is great, their pressure tends to compact the stone firmly, which if it is not of sufficient strength, will be crushed and ground to

dust. On the other hand, where the kind of traffic is lighter, with wheel pressure comparatively small, there is but little grinding or compression. Generally this lighter traffic moves more swiftly so that the effect produced by the horses' hoofs is much more noticeable. The hoofs of a fast running horse hit the road with a quick, hard blow, which has the effect of loosening the particles of broken stone. As there is little compression given by the wheels in this class of traffic, the loosened pieces of stone are not pushed back into place, and this results in what is known as "raveling."

The action of motor vehicle traffic on a macadam surface is far more destructive than any other to which our roads are subjected. Careful observations made by the Office of Public Roads at Washington show that the destructive action is almost wholly due to the driving wheels. The scour or shear on the road surface that is produced when heavy cars are driven at high speed is sufficient to displace the surface particles of the road which are sucked up and dispersed in clouds of dust. The stones in the upper portion of the road are bared and, in time, loosened. The surface of the road, particularly in dry weather, becomes covered with pieces of loosened stone.

Experience has shown that different varieties of stone act differently under traffic. Thus, some varieties will make a hard, firm road if there are many vehicles moving over the road; while other varieties are found to be quickly ground into dust under similar conditions but give good results where the traffic is lighter. The heavy traffic is found to require a hard, tough stone, with a high power of resistance to wear, and which will require great force to split. There are few varieties of rock which have these physical properties that are not adapted for the surface of a macadam road which will be subjected to a large amount of heavy traffic. Such traffic is not usually found on the majority of country roads, or, if found, there is seldom a sufficient amount of it to keep the hardest varieties of stone in place unless they have a third physical property, that of binding readily. Such stone when ground to dust will cement together, and this property is called its cementing value. If this property is wanting or exists only to a slight degree in a rock, it will be found practically useless to supply such material to the ordinary country road. And in proportion as the traffic over one road is lighter in character than that of another, so too should the cementing value of the material used in the former case exceed that used in the road with heavier traffic.

The road builder is often confronted with the problem of how best to use a comparatively soft material under conditions which require the hardest variety of

rock, or at least where such rocks could be used to advantage. The same material can produce under the same conditions quite different results according to the way it is handled. For example, the amount of wear which a road can sustain can be greatly increased by a change in the size of the pieces of broken stone which make up the second or wearing course of the road. A soft limestone or other variety of rock having a low resistance to wear should be broken in larger pieces than harder material would be used; that is, the second or wearing course should consist of the larger sizes, which are larger for softer varieties of stone than for harder varieties. A soft variety of rock used to best advantage may make as durable a road as a harder variety of material improperly used.

It is, therefore, advised that all rocks which have high cementing value but small resistance to wear (that is, having the coefficient according to the Duval test of less than 10), should have the 2 and 3-in. pieces placed in the second course. The sizes permitted may be slightly larger in all courses for rocks with high cementing value and low wearing qualities. Thus, the crusher could be opened wider and more material put through in a given time, which would cheapen its cost, and, therefore, in a measure offset the additional cost of maintenance, which might be necessary where a rather soft variety of rock was used with a moderately heavy traffic.

The fact that pieces of rock from 2 to 3 in. in size will lock or key together more firmly than 1-in. size makes a surface composed of the larger sizes resist more effectively the action of automobile traffic. In many instances observed by the writer it has been noticed that the first place to give way has been where there evidently has been a cluster of finer particles.

Reference has been made to the Duval and other tests of road material. It is, perhaps, sufficient here to say that a full description and discussion of the tests are found in the bulletins of the Office of Public Roads, Washington, D. C., which may be had on application. The road builder is, however, not often given an opportunity to make much of a selection of materials; he must use what is at hand and make the best of it; so that there is but a limited field of application for the deductions from the refined methods of the laboratory. But even with a single source of material, it is valuable to have thorough laboratory tests made, which should be compared carefully with the practical service tests, as it is only by such comparisons that intelligent interpretation of the laboratory results are possible. Occasional tests will detect any variation in the rock used; they also give valuable information as to what part of a quarry, not uniform in its rock, yields the best material for this service.

Spreading.

The broken stone for the second course is not to be spread before the foundation or first course has been completed and shoulders made as herein specified.

The broken stone is to be spread upon the first course, prepared as herein described, with shovels from piles alongside the road or from a dumping board, or it may be spread directly from wagons, especially constructed for this purpose and approved by the engineer; but in no case shall the broken stone be dumped in piles directly upon the first course unless it is entirely rehandled.

As soon as spread, the layer of stone is thoroughly raised or harrowed with a tooth harrow, and finally trimmed true to the shape of the cross-section.

Note: The object of having the stone spread in the manner specified above is to secure a uniform amount of stone for any given area; so that when compacted by the roller it will compress evenly at all points and no bumps will be formed, as will be the case if the stone is dumped in a pile from a wagon and raked outwards in all directions until apparently spread to the required thickness. For in the center of every pile of stone so dumped there is a core formed where the pieces have been more closely jammed together by the weight of other pieces on top of them, so that when the roller passes over the stone there will be formed little mounds wherever these compacted cores were made, which no amount of rolling will efface. It may not be practicable to have the stone dumped at the side of the road or to have a dumping board at hand, and it would then be necessary to permit the second course of stone to be dumped upon the first course, in which case care should be taken to have the pile of stone raked or shoveled over so as to loosen all parts of it equally.

Rolling.

After the broken stone for the second course has been spread to a uniform thickness, and has a proper cross-section, it is to be rolled with a steam roller weighing not less than ten tons until it is compacted to form a firm, smooth surface.

The rolling is to begin at the sides, the shoulders first being rolled firm. When completed the surface of the shoulders and of the second course of broken stone should be smooth and continuous with a cross slope of inches to 1 foot.

If any unevenness or depressions appear during or after the rolling of the second course, either on the surface of the shoulder or the broken stone, suitable material shall be added to remove all such unevenness or depressions, earth being used on the shoulders and stone for the broken stone surface.

Thickness.

The thickness of the second course of broken stone, after thorough rolling, is to be that of the class of macadam construction, specified for any particular place, as described under 6-in., 8-in., and 10-in. macadam. On a telford foundation the thickness shall not be less than 4 ins.

If for any reason a greater thickness than specified is made by the contractor no extra allowance for such additional thickness will be made.

Note: The second course must be rolled until every particle of stone has been wedged firmly against its neighbors. Satisfactory results cannot be obtained if too great a thickness of stone is rolled at once. Not over 6 in. measured loose should be attempted. There are many varieties which will not compact readily, and give great trouble in rolling. No specific directions can be given which will prove applicable in every case. If the conditions are such as to make it imperative to use

material in which there is considerable mica, it will usually be found necessary to sprinkle it lightly with sand and water to prevent the stone creeping as the roller passes over it. Frequently poor results are caused by attempting to operate the roller at too great a speed, for material which is hard to manage may often be easily handled by reducing the speed of the roller to a rate of about one mile an hour. It may sometimes be necessary, even then, to use a little sand or stone screenings to hold the material in place so that the pieces of stone will be compacted and not grind one another into rounded fragments. But little trouble of this sort is experienced with the softer varieties of rock. The danger in such cases is that the road may be rolled too much. This can be readily told by watching the pieces of stone on the surface; if they are being crushed or broken, the rolling should not be continued. This applies particularly to the softer varieties of limestone.

It is necessary in shaping up whatever uneven places may appear to use material of exactly the same character as that of which the surface is composed. The earth should be filled up with earth, and broken stone with broken stone of the same size. If the depression is so slight that a single thickness of the broken stone is too thick, the way to fill such a depression is to loosen the surface all about it and add a small amount of broken stone, and then roll the whole down. A little experience will soon show about how much higher the loosened portion should be in order to roll down to the required surface.

Third Course for Macadam or Telford Construction.

The third course of macadam or telford construction is to consist of rock screening varying from dust to one-inch pieces. The screenings are to contain all of the dust.

Note: If the material of which the screenings are made (which would usually be the same as that of the second course) is extremely hard, that is, has a Duval coefficient of wear of 20 per cent or over, the size of the largest pieces should not be over $\frac{1}{2}$ in. If softer material is used, the screenings may contain pieces as large as 1 in. in diameter.

The screenings from some varieties of rock are extremely difficult to work properly; that is, they do not seem to bind together and, after rolling, when dried out, loosen and do not hold the surface of the road as it is desired. For example, there are some crystalline limestones, a number of which are found in Illinois, particularly the stone at the State Prison used by the State Highway Commission, which do not bind with any facility. The laboratory tests also show it deficient in cementing quality. It is found, however, that when this dust is combined with silica the combination produces a material which binds very much better than either one alone. This fact was observed on roads

when had been sprinkled with a light covering of gravel or coarse sand. An investigation in the laboratory combining silica with such limestone dust also showed an increase in cementing power. In all of the construction carried on by the State Highway Commission the past year we have advised, where the material from the Joliet prison has been used, that it be bonded with a thin layer of fine gravel or very coarse sand; where this has been done the result has been very much more satisfactory than where roads were built using the natural rock screenings alone.

Spreading Screenings.

After the second course of stone has been rolled and completed as specified, the screenings are to be spread, but in no case are screenings to be used until the second course has been thoroughly rolled and compacted. The screenings are to be spread dry with shovels from piles along the road, or from dumping boards, but in no case are the screenings to be dumped directly on the second course. The quantity of screenings used is to be such as will just cover the second course.

Note: There usually seems to be a strong inclination to put on screenings too thick or too much at one time. The road surface apparently is finished quicker and with less work where a layer of screenings from $\frac{3}{4}$ to $1\frac{1}{2}$ in. thick is spread at one time.

Where it is desirable, as on park roads, to have a soft surface, a greater layer of screenings may eventually be placed, as such roads naturally receive or are expected to receive, constant attention, and can thus be maintained in good condition. In general, however, it is a safe rule to use as few screenings as possible. A road with too much screenings will have a deadened sound as vehicles move over it.

Watering and Rolling.

After the screenings are spread they are to be sprinkled with water from a properly constructed sprinkling cart, and then rolled with a steam roller weighing not less than ten tons. The amount of water necessary is to be determined by the engineer. The rolling is to begin at the sides and to continue until the surface is hard and smooth and shows no perceptible tracks from vehicles passing over it.

If, after rolling the screenings, the stone appears at the surface, additional screenings shall be used in such places.

The rolling and watering shall continue until the water flushes to the surface. The rolling is to extend over the whole width of the road including the shoulders.

Note: The best results are invariably obtained if the screenings are first wet and then rolled. Often it will be impracticable to get a sufficient supply of water to the road for this purpose, in which case the screenings may be spread and the road used as little as possible until a shower does the sprinkling. As soon as it is possible, either during the shower or immediately after, the rolling should be started, and continued until the surface of the road has become practically impervious to water. Where it is necessary for the road to be used as soon as the screenings are spread, and it is impossible to water them, they may be partially rolled dry and then another layer of screenings spread. This excess of screenings will make the road somewhat more dusty or muddy, accord-

ing to the wet weather, and the surface will require more careful watching than is the case where the screenings are sprinkled before rolling. Care should also be taken not to drench the screenings at first, as the water will go immediately through the loose stone of the road into the foundation, softening it, and rolling will have to be suspended until it dries out. The first sprinkling should, therefore, be light—merely enough to permit the dust to bind or cake together. The screenings should be added a little at a time so that they will fill all interstices thoroughly, but not form a crust on the road, which is liable to disintegrate and peel off. As soon as the interstices are thoroughly filled with the screenings, and consequently made impervious to water, the sprinkling may be heavier than at first. Where the roadbed is on a gravelly or sandy soil which is naturally well drained, but little damage will result from copious sprinkling; but where the roadbed is on a clay soil care must be exercised if the foundation is to be kept firm enough to support the roller without jamming the broken stone into the earth, which would result in an uneven place in the road-surface.

Unevenness and Depressions.

If any unevenness or depressions appear in the road surface after rolling the screenings, broken stone and screenings shall be used until they are removed and the finished surface conforms to the proper cross section, as shown on the accompanying plans, and presents a smooth, even appearance.

Note: The following directions concerning the application of screenings were prepared by the writer for the use in the work of the Illinois Highway Commission:

Screenings must not be dumped directly on the broken stone but must invariably be placed at one side of the roadway.

The shoulders must be shaped and rolled for two or three feet from the edge of the stone, the surplus earth then being graded off towards the gutter and the shoulders re-rolled, not less than five feet where conditions will permit. This will make a firm, smooth space on which to deposit the loads of screenings.

The last course of stone must be thoroughly rolled until the stone has compacted, and each piece is in contact firmly so that the stone does not jar or move when wagons go over it. When the stone is thus firmly packed, the screenings are to be spread, not by shovelfuls in a place but by having each shovelful spread parallel with the road from a square point shovel over the greatest area possible. The first application should be just enough to fill the interstices between the stones. The screenings should then be very lightly sprinkled. Where the screenings have been washed down between the stones, a very light additional layer of screenings should be put on. Then have the roller pass over the work, beginning at the edges and working towards the center, once over every part. Where nec-

essary, add more screenings and again roll.

If a gravel binder is used, see that the screenings fill the interstices only partly, then spread on some of the gravel binder. After the first rolling, put on where necessary more binder, and then sprinkle lightly.

The screenings or binder, after this sprinkling, may stick to the wheels, and it is better, therefore, to do this sprinkling the last thing at night, and roll the road in the morning. After this rolling, and adding what binder may be necessary here and there, the road will probably be sufficiently water tight so that more water and binder may be added. As soon as the road becomes water tight it should be well sprinkled, if possible, having the water play on the roller wheels. The screenings or binder must be placed on the road and that part of the road finished immediately and traffic blocked off until the road has taken on a set.

Unless the work is done in this way, it will be found that the road when partly screened, and travel allowed to go upon it, will become loosened. The screenings will get between the stones and entirely surround many of the pieces of stone in the top of the road. Where this happens, it will be found that they will easily pick out. This explains why it is that we find occasionally patches here and there where the stone picks out readily after we have finished the road.

Travel over broken stone before the screenings are added does no particular harm, but screenings must not be put on crushed stone that is loose, and after screenings are placed, that part of the work must be finished immediately before allowing any other travel to come upon it.

Constructing a 25-Ft. Sidewalk With Concrete Mixers.

Machine mixing has commonly been regarded as unprofitable by contractors for concrete walks. Doubtless it is so for much small work, as ordinarily managed, but this fact is not generally true. Ma-

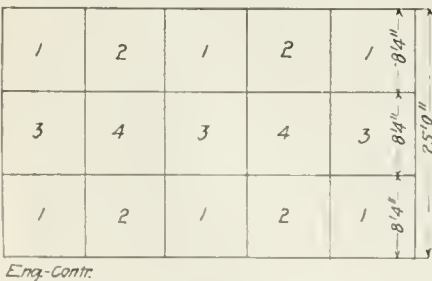


Fig. 1.

chine mixing in the better types of batch mixers is more certain and reliable than hand mixing. Its economy, too, is evident in a great many cases. When the walk is of unusual size or where a city department does its own work the economy is particularly certain. In the accompanying

engraving we show a machine mixer being used in constructing a 25-ft. sidewalk on Michigan Ave., facing Grant Park, Chicago, Ill. The work is being done by the Chicago South Park Commission and the mixer used is the portable, gasoline operated non-tilting mixer made by the Chicago Concrete Machinery Co., Chicago, Ill. In fact three of these machines are being used on the work.

The sidewalk as before stated is 25 ft. wide. It is being constructed in "squares" 8 ft. 4 ins. square. The foundation is 12 ins. of cinders wetted and rolled hard with a steam roller. The 1-2-4 7/8-in. stone concrete base 4 ins. thick is laid on this foundation and thoroughly tamped. As soon as the base is placed the 1-2 1/2 mortar wearing surface 1 in. thick is placed, worked down with a straight edge and lightly troweled. The base concrete is a medium mixture, the tamping bringing



Fig. 2—Sidewalk Construction Work on Michigan Ave., Chicago, Ill.

only a slight film of water to the surface. The mortar mixture is wet enough to readily float into place under the straight edge. The 8-ft. 4-in. squares are laid in the order indicated by the numerals in the sketch, Fig. 1. Wooden forms are used for the isolated squares and for the open sides of the other squares.

The location of the mixer in relation to the work is indicated by the view Fig. 2. The mixers have automatic charging attachments, which necessitate an incline only 18 ins. high in handling the materials to the mixer in barrows. The mixed concrete is taken away in barrows, the mixer having a tilting chute discharge which permits a barrow load to be discharged at a time. The view, Fig. 2, shows other details of the work which is an excellent example of modern cement sidewalk construction.

Cost of Scarifying Macadam in Rhode Island.

In breaking up the crust of an old macadam road preparatory to mixing it with tar or asphaltic oil, a scarifier drawn by a steam roller is cheaper than the use of "picks" in the rear wheels of the roller.

This is well illustrated by the following costs of scarifying which have been furnished to us by Mr. Arthur H. Blanchard,

assistant engineer of the State Board of Public Roads, Providence, R. I.

An old macadam road at Tiverton, R. I., was scarified to a depth of 3 or 4 ins. at a cost of 0.7 ct. per sq. yd. The steam roller and scarifier were rented. The price paid for the steam roller, including fuel and wages of engineman, was \$10 per day of 10 hours, which is a reasonable price. The price paid for the use of the scarifier was \$5 a day, which is reasonable when due allowance is made for the cost of sharpening its teeth. Two laborers, at \$2.50 each per 10 hour day, operated the scarifier. Therefore the daily cost was as follows:

	Per Day.
Roller, including engineman.....	\$10.00
Scarifier	5.00
2 laborers at \$2.50.....	5.00
Total	\$20.00
The average 10-hr. day's work was 2,738	

sq. yds. scarified, hence the cost per square yard was:	Per Sq. Yd.
	Cts.
Roller, including engineman.....	0.36
Scarifier	0.18
Laborers	0.18
Total	0.72

For comparative costs of scarifying, the reader is referred to Gillette's "Handbook of Cost Data," page 152. Costs are also given there of breaking up macadam with the "picks" in the rear wheels of the roller.

It may be well to add that the practice of using "picks" in the rear wheels of a steam roller is not to be commended, for the resulting shocks to the whole machine, and particularly to the boiler, are injurious. Boiler tubes quickly become loosened and leak badly under this severe service.

A recent Consular Report states that according to a table printed in a Nottingham newspaper, showing the average speed per hour of electric street cars in the towns and cities of the United Kingdom, the lowest average is in Northampton, 5.60 miles an hour, and the fastest in Hull and Nelson, 10 miles an hour. The Nottingham average is 6 1/2 miles. In all but 12 of the 73 places in the list, the average speed is below 8 miles an hour.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods of Protecting Embankments From the Effect of High Water by Riprap or Otherwise and Some Statements of Cost.

The following methods and costs of railway embankment protection have been furnished a committee of the Association of Railway Superintendents of Bridges and Buildings and formed a part of this committee's report at the recent annual convention:

Pittsburg & Lake Erie R. R.—Riprap on the Pittsburg & Lake Erie R. R. is a very important matter, as this road runs close to the banks of the Mahoning, Ohio, Youghogheny and Monongahela rivers for a distance of 165 miles.

At some points where riprapping is required and the tracks are far enough away from the harbor line to permit, the riprapping is done by throwing the stone over the bank, letting them roll or slide down, making a slope about $1\frac{1}{2}$ to 1, slope varying in thickness from 2 ft. to 4 ft. We use for this quarry spalls or small stone such as can be handled by one man, and in some cases we use furnace slag, which becomes hard from the effects of the weather and makes very good riprapping, which costs from \$1 to \$2 per sq. yd.

At points where we are close to the harbor line we use stone such as can be handled by one man and laid in place by track laborers on a slope of 1 to 1, varying in thickness from 2 to 3 ft., costing about \$3 per sq. yd. Fig. 1 shows styles of riprapping along the banks of the Ohio and Monongahela rivers at Pittsburg.

In riprapping piers and abutments of bridges we use in some cases, where the current is not very rapid, small stone such as can be handled by one man, and where the current is very rapid we use large breakwater stones, usually dropping them around the piers or abutments, allowing them to find their own bearing.

In all cases I would prefer the large breakwater stones filled in with small stones to fill up the crevices between the large stones and make the riprapping as compact as possible to prevent any washing.

Northern Pacific Ry. (F. Ingalls).—On most waterways of the Northern Pacific Ry. through the prairie country of North Dakota we use boulders which can be picked up on the prairie and loaded on cars for \$1 per cu. yd. and placed for 75 cts. per yard. We also use stone for protection of banks from wave wash where permanent protection is required. For temporary protection on times of occasional high water we use sand bags and fascines.

Portable snow fence is also used in emergencies. This fence is made in panels 16 ft. long and when placed along the bank will break the force of the waves.

At one place where we have a mile of track exposed to occasional wave wash we have sodded the banks, but have had no high water there since the banks were sodded, so we cannot say what the benefit will be, but believe it will give good protection. At the crossing over the Missouri river we have experienced all kinds of trouble from bank cutting for approximately two miles above the bridge. The bridge itself is protected by dykes built of piles, fascines and rocks. For the protection of banks above the bridge, dykes were built of mattresses composed of willows and stone and held in place by piling. Most of this work was done by the government, as the cutting of the banks en-

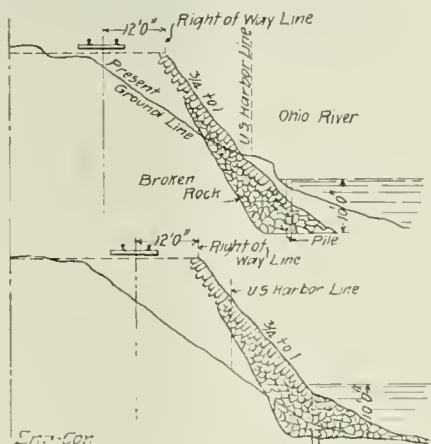


FIG. 1—Styles of Riprapping Along Ohio and Monongahela Rivers.

dangered Mandan on the west side of the river and would also have destroyed the harbor for boats at Bismarck on the east side of the river.

St. Louis Southwestern Ry. Co. (J. S. Berry).—We have used several methods for protecting river embankments on our line from caving on what are considered as very difficult streams to control, the Mississippi River, Arkansas River and Red River. One of my methods is to first slope embankments to pitch of 3 to 1 and drive piling at toe of slope about 50 ft. apart; then weave mattress of willow of sufficient length so that it will lay from toe of slope out into river about 50 ft. The mattress is then sunk with rocks, and placed in proper position and the entire bank is then riprapped with rock all the way and about 10 ft. at the top of bank, so that high water cannot cut in behind it.

I consider this method of bank protec-

tion practical and it has proven satisfactory. It will cost approximately \$8 per running foot of embankment.

I have been using another method which has proven very effective, this being to drive deflecting dykes, piles being driven about 8 ft. apart, dykes spaced about every 30 ft.; 2x6 planks are spiked onto piles about 6 ins. apart from the top of piling to bottom of stream. These deflecting dykes will collect the debris and the chambers will gradually fill in and form a bar. I also consider this method effective in case of very rapid currents; its cost will approximate \$6 per lin. ft. all complete.

There are other methods being used, some of them being quite effective. There is what is known as the system of mudrafts and hollow fascines. These are generally constructed out of willows and poles, then put into proper position and anchored. They will gradually fill in with sand and silt from high waters and sink in place, and embankment usually fills in behind it. It also has a tendency to check the current. This, however, is expensive work, costing \$9 per lin. ft. The mudrafts cost about \$6.

The Value of Second Quality Rope.

The question is often asked, "Does it pay to buy and use second quality manila rope?" This question was recently answered by taking a coil of $\frac{1}{2}$ -in. manila rope of first quality, manufactured by one of the large cordage companies and also a coil of second quality rope of the same size manufactured by another company.

The coils were accurately weighed and measured and a number of pieces of each were tested for strength upon a reliable testing machine. From the various weights, measurements and tests the following results were obtained:

	1st quality.	2d quality.
Length of rope in coil.....	1,250 ft.	1,070 ft.
Wt. of coil with lashings.....	97 lbs.	97 lbs.
Wt. of lashings.....	1 lb.	3 lbs.
Assumed price per lb.	12 cts.	9 cts.
Comparative price per 100 ft.	93 cts.	82 cts.
Breaking strength.....	2,907 lbs.	1,450 lbs.
Comparative value (estimated)	12 cts.	5½ cts.

These figures speak for themselves. The cost per 100 ft. of rope is but slightly more for the first quality than the second quality, while the breaking strength is twice as great. From these figures it is evident that when buying first quality rope, the money is well spent, while with second quality rope strength sacrificed, and taking this into consideration, money is not saved.

These figures are furnished by the Plymouth Cordage Co., of North Plymouth, Mass.

During the last year the electric traction systems of Chicago, Ill., carried a total of 618,300,266 passengers.

Tests Showing the Efficiency of Turbine Pumps.

Some interesting tests of centrifugal or turbine pumps have been made public, and we print the results of these tests below. The tests were made by Prof. James E. Denton, M. E., of Stevens Institute of Technology, of Hoboken, N. J.

The pump was a Lea-Degen, two-stage turbine pump, with a 10-in. diameter suction pipe, and a 10 in. discharge. The outline diameter of each wheel was 21 ins., with 8 blades. The pump was manufactured by the Lea Equipment Co., 136 Liberty St., New York.

The pump was driven by a General Electric, direct-current multipolar dynamo of 385 amperes and 220 volts capacity used as a motor, and directly connected to the pump shaft.

It was arranged, Fig. 1, to lift water by suction, about 7 ft., from a well fed from the Raritan Canal and to deliver it through a 10-in. throttle-valve, C, to a 6½-in. bell-shaped nozzle, H, to a weir tank, M, which was about 25 ft. long by 10 ft. wide and 10 ft. deep, whence the water flowed through a rectangular notch 3.02 ft. wide in a ¼-in. beveled iron plate, L, set in the middle of the end of the tank about 7 ft. above the bottom.

A pitot tube, I, was applied under the nozzle, and its indications used as a means of quick adjusting the discharge of pump to the several amounts of flow necessary for the tests.

The amount of water flowing was calculated from the weir height by the Francis formula

$$Q = 3.33 (1 - 0.2h) h^{\frac{3}{2}}$$

The weir heights were taken with a hook-gauge, O, in a barrel, N, communicating with the tank by an inch pipe, P, having an open end square with the flow of water at a point 13 ft. back of the notch. The surface of the water approaching the weir was made perfectly smooth by means of a grill lattice 6 ft. from the discharge nozzle, and dam-boards set by trial.

The zero of the hook-gauge was determined daily with a straight-edge, and checked by a surveyor's level. Readings of the gauge could be easily made to 1/64 in. The leakage of the weir was frequently determined. It remained practically constant at 18 gals. per minute, which was added to the quantity calculated by the weir formula.

The total lift of the pump was determined by adding the vacuum shown by a mercury gauge, E, to the pressure above the atmosphere shown at F, the pipe diameter being the same at both points.

At F both a pressure gauge and a mercury tube were used during most of the tests, the gauge being calibrated by the Crosby testing apparatus. To secure a smooth surface in the main pipe for measuring the pressure at E and F the latter was taken through a 1/32-in. hole,

Q, at Fig. 1 in the top of a ¼-in. polished brass tube, with a pointed closed end lying against the current.

The pump was designed for practically equal efficiency for the range of speed between 400 and 600 revolutions per minute. Therefore an efficiency test was made at 400, 500 and 600 revolutions, respectively.

At each speed the steps in the determination of the maximum efficiency were as follows:

Weir gallons per min.	Total lift. Feet.	Outlet pressure. Feet.	Suction lift. Feet.	Water horse-power	Horse-power to drive pump.	Weir height. Feet.	Pitot ratio.	Watts to drive motor.	Revs. per min.	Efficiency.
G.						H	C.			E.
400 REVOLUTIONS.										
1	2	3	4	5	6	7	8	9	10	11
2828	33.65	20.29	13.36	24.08	34.22	0.754	0.982	29830	401	70.37
2574	38.55	26.32	12.33	25.10	33.78	0.707	0.981	29484	402	74.30
2236	43.63	32.41	11.23	25.34	32.61	0.653	0.988	28576	400	77.70
1984	47.49	37.19	10.23	23.84	30.96	0.590	0.992	27300	401	77.00
1328	52.39	43.98	8.41	17.60	24.86	0.448	.....	22570	401	70.79
852	55.00	47.69	7.31	11.86	19.02	0.330	.....	18042	401	62.42
0	54.93	48.16	6.77	0	7.7	0.0	.....	9400	402	0
500 REVOLUTIONS.										
3517	44.81	27.85	16.96	39.87	62.58	0.878	0.965	51700	501	63.71
3207	58.09	43.17	14.92	47.13	63.64	0.823	0.987	52496	500	74.05
3005	63.12	49.28	13.84	47.99	62.63	0.787	0.984	51736	500	76.62
2794	67.44	54.48	12.96	47.67	61.41	0.748	0.996	50830	500	77.62
2428	72.38	60.84	11.54	44.46	58.16	0.678	0.995	48400	500	76.04
1929	79.09	69.26	9.83	38.60	51.99	0.578	0.989	43800	500	74.24
1289	84.26	76.16	8.10	27.48	41.11	0.438	.....	35680	501	66.84
0	83.04	76.27	6.77	0	12.07	0.0	.....	14012	502	0
600 REVOLUTIONS.										
3806	50.65	32.11	18.54	48.58	89.40	0.928	0.974	74365	600	54.34
3440	95.13	34.10	16.36	82.47	106.50	0.864	0.973	92115	600	77.41
3235	100.71	36.97	15.31	82.10	105.30	0.828	0.987	91052	600	77.97
2552	110.46	42.45	12.40	71.09	95.40	0.703	0.997	89220	600	74.52
1805	118.21	46.95	9.76	53.77	76.60	0.553	0.998	63300	598	70.19
1139	125.67	50.90	8.09	36.07	60.10	0.401	.....	51012	599	60.02
0	122.08	49.80	7.04	0	22.90	0.0	.....	28880	600	0

The useful work of the pump is, (column 5),

$$\text{Water H. P.} = \begin{cases} \frac{\text{Lbs. water delivered per minute} \times \text{Total lift in ft.}}{33000} \\ 0.000252 \times \text{Gals. per minute} \times \text{Total lift in ft.} \end{cases}$$

The total lift is the sum of the suction vacuum (column 4), and the pressure (col-

umn 3), in front of the throttle-valve, expressed in feet of water.

The efficiency is then (column 11)

$$E = \frac{\text{Water H. P.}}{\text{H. P. to drive pump}}$$

The prony brake was of the two-semi-circular, solid-block type applied to a 28-in. pulley, with a 6-ft. lever-arm acting on a knife-edge on a tested platform-scales. It

was carefully balanced with its pulley by mounting the whole combination, with a mandril through the pulley, on straight-edges. A copious stream of water applied to a nipple in the top block, through a long vertical flexible hose, and a hand-tightened wheel, with a leverage of 1,000 to 1, enabled the highest loads to be maintained indefinitely with a very steady equipoise of the scale-beam. The

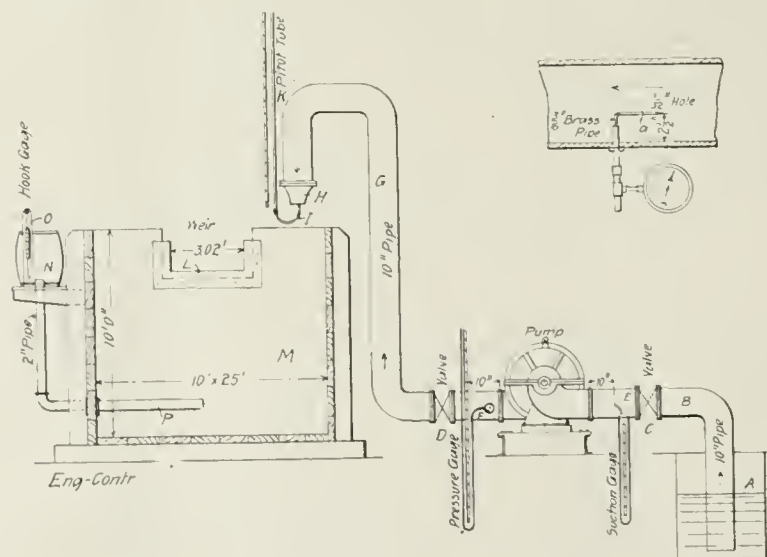


Fig. 1—Arrangement for Testing Turbine Pump.

electrical readings were made from a Weston instrument from the laboratory of the Stevens Institute.

The ratio of the quantity of water given by the weir to that given by the pitot tube is shown in column 8. This ratio is the value of the coefficient C in the formula for cubic feet per second.

$$Q_1 = C \times \text{Area of nozzle} \sqrt{2g \times \text{pitot head.}}$$

The tests show that the pump afforded the following results under conditions of maximum efficiency:

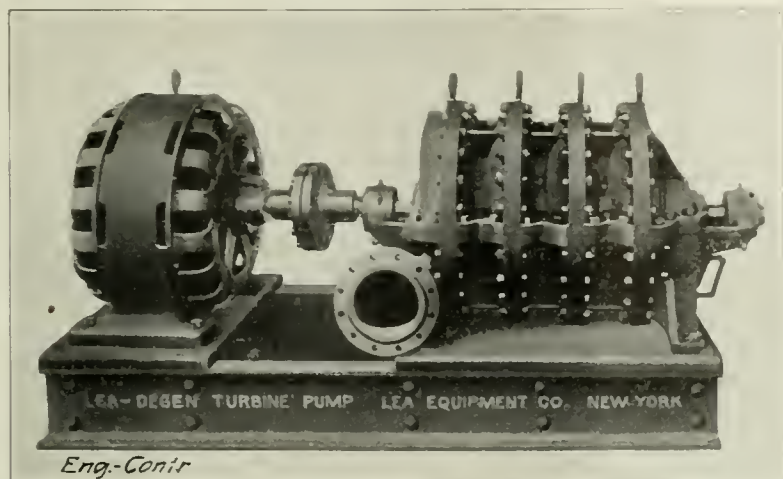


Fig. 2—The Lea-Degen Turbine Pump.

At 400 revs. 77.7 per cent eff. with a cap. of 2,296 gals. under 43.6 ft. lift.

At 500 revs. 77.6 per cent eff. with a cap. of 2,794 gals. under 67.4 ft. lift.

At 600 revs. 77.97 per cent eff. with a cap. of 3,235 gals. under 100.7 ft. lift.

In round numbers, therefore, the capacity at maximum efficiency is directly proportional to the revolutions, and the lift, or head, is proportional to the square of the revolutions. At each speed the efficiency averaged more than 76 per cent over a range of 600 gallons of capacity for the lower two speeds, and 900 gallons at the higher speed, the head remaining nearly constant.

A petition has been made to the U. S. Supreme Court for an injunction to restrain the State of New Jersey from constructing the Passaic Valley trunk sewer. The petition, which has been made for the Attorney General of New York State, alleges that the discharge of crude sewage into New York Bay would be a menace to health and a damage to the harbor. The application for the injunction is based upon a compact between the governments of New York and New Jersey in 1833, under which New Jersey, according to the attorney for New York, surrendered to New York all police and sanitary jurisdiction of the land below low-water mark along the New Jersey shore from a point opposite the northern end of Manhattan Island to Perth Amboy.

Detail Labor Cost of Constructing 15 Brick Vaults for Underground Conduit.

The following detail costs of constructing 15 brick vaults for underground conduit supplement the costs for 74 vaults published in our issue of Sept. 23, 1908. The costs given here are itemized in more detail; they show separately the costs of placing floors and tops and also the cost of board and car fare. They also show work done in paved streets. The paving was cedar

Cost of Operation and Maintenance of Sand Filters at Reading, Pa.

The water supply of Reading, Pa. is obtained by gravity systems and by pumping. Two of the gravity supplies—the Antietam supply and the Egelman supply—are filtered. In the report by Mr. Emil L. Neubling, Superintendent and Engineer of Waterworks, for the fiscal year ending April 6, 1908, data on the operation of these filter plants are given, and the matter in this article has been taken from that report.

Antietam Filters—The Antietam supply is obtained from a drainage area of 5.41 square miles. The storage reservoir capacity is 101,000,000 gallons. During the year this supply was treated with copper sulphate in order to remove the organism anabaena and to lighten the work of scraping at the Antietam filters. Two treatments were given and the effect upon the operation of the filters was to reduce the total number of scrapings from 62 in the previous year to 48 during the past year.

The Antietam filters consist of three open sand beds, 108x144 ft. each, the capacity of each bed being 1,750,000 gallons per day. The filters were put into service on May 11, 1905. The total cost of operation and maintenance was \$3,909.46 or \$474.76 less than the previous year. Owing to the decreased efficiency of labor the cost of refilling the beds was 42 per cent higher per cubic yard than during the previous year. The cost of washing sand, however, was very material-

TABLE SHOWING LABOR COST OF CONSTRUCTING 15 BRICK VAULTS 3 FT. 6 INS. X 4 FT. 6 INS. X 4 FT. 6 INS. FOR UNDERGROUND CONDUIT.

Vault No.	Cost of teaming.	Cost of excavating.	Cost of placing floor.	Cost of laying brick.	Cost of placing top.	Cost of supervision.	Board.	Car fare.	Total cost.
1.....	\$3.10	\$4.35	\$0.75	\$11.90	\$5.25	\$2.85	\$0.30	\$0.04	\$28.54
2.....	3.00	4.50	0.80	12.50	4.95	3.00	0.25	0.06	29.06
3.....	2.95	5.00	0.75	11.70	5.00	3.10	0.20	0.08	28.78
4.....	3.25	4.15	0.85	11.50	5.05	2.75	0.20	0.05	27.80
5.....	3.10	4.25	0.90	12.05	4.85	2.65	0.30	0.03	28.13
6.....	3.30	4.30	0.65	12.00	4.95	3.05	0.25	0.04	28.54
7.....	2.90	4.40	0.70	13.25	5.40	2.95	0.20	0.05	29.85
8.....	2.95	4.05	0.75	14.20	5.50	2.70	0.15	0.08	30.38
9.....	2.85	4.10	0.80	15.00	4.60	2.80	0.20	0.06	30.41
10.....	3.05	4.20	0.85	11.60	5.80	3.00	0.25	0.04	28.79
11.....	3.00	4.50	0.80	11.90	5.25	2.85	0.20	0.03	28.53
12.....	2.85	4.25	0.90	12.00	5.30	3.05	0.15	0.05	28.55
13.....	3.15	4.30	0.70	11.80	5.40	2.75	0.30	0.07	28.47
14.....	3.20	4.50	0.85	11.70	5.05	2.90	0.35	0.06	28.61
15.....	2.90	4.15	0.75	12.10	5.15	2.95	0.25	0.05	28.30
Total..	\$45.55	\$65.00	\$11.80	\$185.20	\$77.50	\$43.35	\$3.55	\$0.79	\$432.74
Avg'ge..	\$3.04	\$4.33	\$0.79	\$12.35	\$5.16	\$2.89	\$0.24	\$0.05	\$28.85

vault construction was the same as that described in the previous article. We are indebted to Mr. Clarence Mayer, Chicago, Ill., for these data.

Municipal improvements made by Americans in Panama, Colon and the Canal Zone, up to the close of the fiscal year 1908, cost \$5,770,750.87, distributed as follows:

Panama water works and sewers	\$853,849.23
Colon water works and sewers	601,043.91
Zone water works and sewers	2,358,840.44
Paving, Panama	489,007.77
Paving, Colon	293,231.26
Zone roadways	1,174,778.26
Total	\$5,770,750.87

ly reduced on account of placing the filter keeper in charge of the washing, thereby saving the services of an engineer. The cost of washing sand was reduced 11 cts. per sq. yd.

During February and March, 1908, 835 cu. yds. of ice was removed from the filter. The mean thickness of the ice was 4.35 ins., and the greatest average thickness was 5.3 ins. in February, when three beds were cleared. In March one bed was cleared, the average thickness of ice being 1.5 ins. The cost of removing the ice was as follows:

	Total.	Per cu. yd.
Labor, 238 hours	\$51.69	\$0.662
Superintendence	6.80	.007
Supplies	.90	.001
Total	\$59.39	\$0.070

It will be noticed common labor was paid about 21 cts. per hour.

The cost of scraping and wheeling out sand was as follows, 1,818 cu. yds. being removed:

	Total.	Per cu. yd.
Labor, 3,589½ hours.....	\$711.77	\$0.391
Superintendence	38.82	.021
Supplies	70.29	.039
Sulphate treatment	42.77	.024

Total\$863.65 \$0.475

The cost of washing sand, 1,831 cu. yds. being washed, was as follows:

	Total.	Per cu. yd.
Labor, 1,539½ hours.....	\$282.38	\$0.154
Superintendence	30.43	.017
Supplies and repairs.....	794.49	.433

Total\$1,107.30 \$0.604

The cost of refilling the beds was as follows, 1,921 cu. yds. of sand being used for refilling:

	Total.	Per cu. yd.
Labor, 4,838 hours.....	\$917.95	\$0.478
Superintendence	37.93	.020
Supplies	18.36	.010

Total\$973.34 \$0.508

The total number of gallons of water filtered during the year was 1,182,557,923. The average quantity of water filtered between scrapings was 73,909,870 gallons or at the rate of 69,626,123 gallons per acre. The average quantity of water filtered per day was 3,231,033 gallons, or at the rate of 3,043,765 gallons per day per acre. The cost of filtering water per million gallons was as follows:

	Per M. gals.	Total. filtered.
Removing ice	\$ 59.39	\$0.050
Scraping and wheeling out sand	863.65	.730
Washing sand	1,107.30	.936
Refilling beds	973.34	.823
Care of grounds	513.86	.434
Analyses	37.38	.030
Watching	150.09	.130
Operation and general maintenance	204.45	.180
Total	\$3,909.46	\$3.313

The cost of filtering water per million gallons, excluding analyses and care of grounds was \$2.84.

Engelman Filters.—The Engelman supply has a drainage area of .6 square miles and a storage reservoir capacity of 6,900,000 gallons. The Engelman filter consist of two open sand beds, 40x55 ft. each; the capacity of each bed is 250,000 gallons per day. The filters were put into service on July 11, 1903.

On account of not washing sand and refilling beds during the year, the cost of operation was considerably less than for the previous year. The unit cost of scraping and wheeling out sand was 3 cts. per cubic yard more than for the previous year, and

the cost of ice removal, 2 cts. per cubic yard less.

A total of 147 cu. yds. of ice was removed from these filters, the mean thickness of the ice being 3.6 ins. The greatest thickness was 5.2 ins. in February, 1908. The cost of removing ice was 10 cts. per cubic yard, the work requiring 67 hours labor at a total cost of \$11.05.

The cost of scraping and wheeling out sand was as follows:

	Total.
Labor, 450½ hours	\$82.82
Superintendence	1.70

Total\$84.52

A total of 122 cu. yds. of sand was removed, the cost per cubic yard being \$0.69.

TABLE I.—COST OF PUMPING WATER AT WATER STATIONS CHICAGO & EASTERN ILLINOIS R. R.

Water Station.	Oxford.	Winthrop. †	Tamms.
Date.....	Oct., 1900	Oct., 1900	1901
Make of engine.....	Stewart	Stewart	Stickney
Size of engine, ins.....	6x10	6x10	6x10
Make of pump.....	Stewart	Stewart	Stickney
Size of pump, ins.....	6x10	5x10	5x10
Vertical section, ft.....	15	15	20
Horizontal suction, ft.....	30	30	15
Size of suction pipe, ft.....	4	4	6
Vertical discharge, ft.....	45	45	45
Horizontal discharge, ft.....	250	75	125
Size of discharge pipe, ins.....	4	4	6
Period of test.....	3 days	5 days	426 days
Fuel.....	Pick-up coal	Mine-run coal	Gasoline
Amount of fuel (gals. or lbs.).....	760	1470	615
Water pumped, gals.....	47,620	125,093	4,836,000
Fuel per 1000 gals. water (gal. or lb.).....	15.9	11.75	0.13
Cost of fuel (gal. or ton).....	\$0.80	\$1.80	\$0.10
Wages of pump, per month.....	17.50	17.50	10.00
Cost ignitor battery per 1000 gals. water.....			\$0.0011
Cost of fuel per 1,000 gals. water.....	\$0.00638	\$0.0106	\$0.013
Cost of labor per 1000 gals. water.....	\$0.0362	\$0.0229	\$0.028
Total cost per 1000 gals. water.....	\$0.04258	\$0.0335	\$0.0421

The total number of gallons of water filtered during the year was 79,784,796. The average quantity of water filtered between scrapings was 4,093,231 gallons, or at the rate of 48,675,541 gallons per acre. The average quantity of water filtered per day was 217,992 gallons, or at the rate of 2,260,888 gallons per acre per day.

The cost of filtering the water per million gallons was as follows:

	Per M. gals.	Total. filtered.
Removing ice	\$ 14.05	\$0.177
Scraping and wheeling out sand	82.82	1.038
Operation and general maintenance	109.56	1.373
Analyses	31.10	.391
Care of grounds	45.25	.567
Total	\$284.48	\$3.546

The cost of filtering water per million gallons, exclusive of cost of analyses and care of grounds was \$2.61.

According to advance proofs of the first annual report of the Board of Supervising Engineers, having in hand the supervision of Chicago's traction system, the average expenses, during the past year, of hauling each passenger, including 5 per cent interest on agreed valuation of properties, was 2.578 cts. The average profit per passenger carried was 4.58 mills, and the city's proportion of profit per passenger carried was 2.519 mills.

Cost of Pumping Water by Gasoline Kerosene and Steam Pumps for Railway Water Supply.*

Chicago & Eastern Illinois R. R.—Mr. A. S. Markley gives the following (Table 'I') results of tests made to determine the cost of pumping at several of the water stations on this road. The results from the steam plant are given merely for comparison.

Chicago & Northwestern Ry.—Table II and III are given by Mr. A. W. Merrick as showing the cost of pumping by gasoline power.

St. Louis & Southwestern Ry.—Mr. J. S. Berry gives the cost of pumping as follows, using an 8-H. P., gear burr, Fair-

banks, Morse & Co., combination outfit:
Suction, size, ins.....
Suction, lift, ft..... 8
Discharge, horizontal, size, ins..... 4
Discharge, horizontal, distance, ft..... 100
Discharge, vertical, size, ins..... 4
Discharge, vertical, distance, ft..... 30

Cost—
Per 1,000 gals., gasoline..... \$0.1700
Per 1,000 gals., coal..... 0.0335
Per 1,000 gals., labor..... 0.0420
Gasoline, per gallon..... 0.1700
Coal, per ton..... 2.90

Pennsylvania Lines West of Pittsburg.—The following data are given by Mr. A. F. Miller:

Cost of pumping water per 1,000 gals., gasoline\$0.00625
Cost of pumping water per 1,000 gals., coal 0.0125
Cost of pumping water per 1,000 gals., labor, gasoline..... 0.02
Cost of pumping water per 1,000 gals., labor, coal..... 0.05
Cost of gasoline per gallon..... 0.10
Cost of coal per ton..... 2.50

Kind of pump, size and H. P.: Combined gasoline, 8-in. piston, 8-in. stroke, 5-H. P. Steam, 10x7x10 in. Blake.

Suction, size and lift: Gasoline, 6-ft. suction, size 6 in., 10 ft. lift. Steam, suction 5 in., increased to 6 in. at pump, lift

*Abstract of committee report at the annual convention of the Association of Railway Superintendents of Bridges and Buildings.

12 ft., distance horizontally 70 ft. in.

Discharge, horizontal distance and size: Gasoline, discharge 5 in. increased to 6 in. at pump, distance 35 ft. Steam, discharge 4 in. increased to 6 in. at pump, distance 50 ft.

Discharge, vertical distance and size: Gasoline, discharge 6 in., distance 35 ft. Steam, discharge 6 in., distance 36 ft.

The difference in cost of labor per thousand gallons of water between coal and

Atchison, Topeka & Santa Fe.—Mr. J.

F. Parker gives the following statement:

"We do not use on this division either gasoline, kerosene or coal. We have three plants where distillate is used and at the balance of our pumping plants we use oil for fuel. I have given you the cost for one gas engine plant, also for one plant where crude oil is used for fuel. The deep well pump and power head used at the distillate plants is, I believe, machinery

we are enabled to raise water 80 ft., including suction and discharge, at a cost of \$.0015 for the oil per 1,000 gals. of water pumped and \$.015 for labor, or a total of \$.0165. At this crude oil plant, Victorville, we produced for the month 3,507,000 gals. of water at a cost of \$77.50 for fuel, labor and maintenance, or an average of \$.022 per 1,000 gals. of water."

Northern Pacific Ry.—Mr. F. Juggalls furnishes the following data, where the cost of pumping with gasoline and coal are very nearly equal:

Cost of pumping water per 1,000 gals., gasoline \$.0333
Cost of pumping water per 1,000 gals., coal 0.02
Cost of pumping water per 1,000 gals., labor, gas..... 0.0225
Cost of pumping water per 1,000 gals., labor, coal..... 0.039
Cost of gasoline per gal..... 0.15
Cost of coal per ton (lignite coal used) 1.25

Kind of pump, size and horse power: 5x12-in. pump in steam plant. 20 HP. gasoline engine, with Smith-Vaile deep well pump, in gasoline plant.

Suction, size and lift: 6-in. suction, 800 ft. long, with 12-ft. lift, in steam plant; 8-in. suction, 18-ft. lift, in gasoline plant.

Discharge, horizontal distance and size: 6-in. discharge, 100 ft. long, in steam plant; 6-in. discharge, 125 ft. long, in gasoline plant.

Discharge, vertical distance and size: 6-in. discharge, 32 ft. to bottom of tank in both plants.

Lake Erie & Western R. R.—Mr. Penwell gives the following data:

"We have but few gasoline pumping stations. We have two small plants that are not considered in this report that are very expensive. My experience has been that if a small supply is required there is but little economy in gasoline outfits, but where a large supply is required we have found the gasoline economical. We have but four gasoline pumping stations and no kerosene plants."

The following table gives results of Mr. Penwell's tests:

Cost of pumping water per 1,000 gals., gasoline \$.032
Cost of pumping water per 1,000 gals., coal 0.057
Cost of pumping water per 1,000 gals., labor 0.012
Cost of gasoline per gal..... 0.11
Cost of coal per ton..... 2.50

Kind of pump, size and horse power: Fairbanks, Morse & Co., Duplex, 10x7x12 in., steam plant. Fairbanks, Morse & Co., 8x12 in., in gasoline plant.

Suction, size and lift: 6-in. suction, 15-ft. lift.

Discharge, horizontal distance and size: 6-in discharge, 3,600 ft. long.

Discharge, vertical distance and size: 6-in. discharge, 50 ft. long.

TABLE II.—COST OF PUMPING WATER PER 1000 GALLONS BY GASOLINE POWER.
(NOT INCLUDING REPAIRS).

	C. & N. W. Ry., 1903.			C. & E. I. R. R., 1899.		
	Richmond, Ill.	Normandy, Ill.	Buda, Ill.	Bourbon, Ill.	Clinton, Ill.	Wellington, Ill.
Kind of engine.....	3½ h.p. Otto	10 h.p. Otto	10 h.p. Otto	6 h.p. Otto	10 h.p. Otto	F. M. & C., 3 h.p. Comb.
Speed of engine, revs.....	390	300	312	5"x18" Curtis	6"x18" Curtis	Combinat'n Eng. and Pump
Kind of pump.....	5"x6" Dem mng	16" Strk. Curtis	16" Strk. Curtis			
Strokes per minute.....	80	40	44			
Size of suction, ins.....	3	4	4			
Size of discharge, ins.....	2½	4	4			
Distance pump to tank, ft.....	860	50	1600	2,600	1,000	300
Height pump to top of tank, ft.....	44	44	44	40	63	35
Height pump above water, ft.....	9	3	2	10 to 25	13	10 to 25
Time of test.....	13 hrs. 15 min.	1 hr. 20 min.	2 hrs. 18 min.	6 hrs.	4 hrs.	131 hrs.
Total gals. pumped.....	21,664	11,314	20,131	26,965	36,180	532,560
Gals. gasoline used.....				2.9	2.25	55.37
Pumper's wages.....	\$0.36	\$0.15	\$0.26	\$10.00	\$10.00	\$10.00
Cost gasoline per 1000 gals. water....	\$0.0115	\$0.0114	\$0.0094	\$0.01075	\$0.00741	\$0.01040
Cost labor per 1000 gals. water.....	\$0.0166	\$0.0133	\$0.0129	\$0.01196	\$0.00960	\$0.01088
Total cost per 1000 gals. water.....	\$0.0281	\$0.0247	\$0.0223	\$0.02271	\$0.01710	\$0.02128

gasoline is explained as lying in salary of pumper, the man using coal receiving \$33 per month and the man using gasoline receiving \$5 per month.

Lake Superior & Ishpeming Ry.—The following data are given by Mr. A. Anderson:

Total cost of pumping for 1907:		
	Whitefish	Slapneck
	Tank.	Tank.
Labor, pumping	\$117.08	\$187.91
Keeping fire under tank	49.26	57.00
Coal for fire under tank	19.37	19.37
Gasoline	53.61	45.93
Oil and waste.....	4.62	6.26
Repairs to engine.....	48.59	72.59
Repairs, buildings or tanks	36.67	169.39

Cost of all labor and material \$329.20 \$558.45

No. gals. water pumped

during year 2,176,000 3,208,500

In explanation of these figures Mr. Anderson says: "The above statement is a record kept of pumping and repair costs at two of our principal water stations for the year 1907, and represents a year's maintenance and operation. You will notice the gasoline cost per 1,000 gals. of water is about \$.0187. I am giving you the above information with the idea that perhaps there are other costs you would like to get at. We use a 3½ HP. gasoline engine at Whitefish and a 2½ HP. at Slapneck. The pumps and engines are located beneath tank. We have to keep fire there from about Nov. 1 to April to keep engines, pumps and water from freezing. We use ordinary soft coal with station stoves, for this purpose."

that is used only on this coast (the Pacific). If you desire I could give a further description of the pump and power head."

The cost at the station using distillate is given by Mr. Parker as follows:

Cost of pumping water per 1,000 gals., distillate \$.039
Cost of pumping water per 1,000 gals., labor 015
Cost of distillate per gal..... .08

Kind of pump, size and horse power: Pomona deep well double-plunger pump,

TABLE III.—AVERAGE COST OF PUMPING WATER PER 100 GALLONS BY GASOLINE ENGINE POWER FOR SIX MONTHS, AUG., 1902, TO JAN., 1903, INCLUSIVE (NOT INCLUDING REPAIRS).

C. & N. W. Ry.	Consumption under 500,000 gals. per month.		Consumption over 500,000 gals. per month.		
	Divisions.	Gals. per month.	Cost per 1000 gals.	Gals. per month.	Cost per 1000 gals.
	Galena.....	334,000	\$.0760	1,532,000	\$.0413
	Wisconsin.....	196,000	.0500	989,000	.0303
	Iowa.....			15,320,000	.0200
	Ashland.....	107,000	.1130	2,034,000	.0306
	I. & M.....	286,000	.0905	4,109,000	.0392
	Average...		\$0.0824		\$0.0323

with No. 18 power head, operated by 10-HP. West Coast gasoline engine.

Suction, size and lift: 6-in. suction, 80-ft. lift.

Discharge, horizontal distance and size: 4-in. discharge, distance 600 ft.

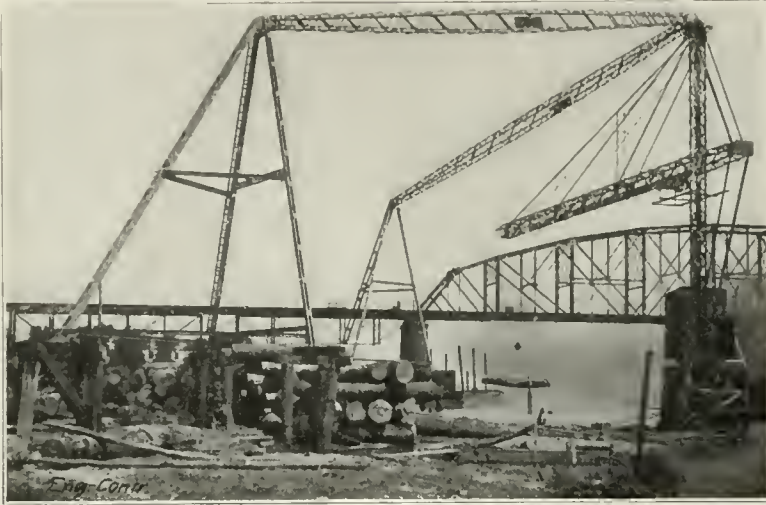
Discharge, vertical distance and size: 4-in. discharge, distance 27 ft.

Regarding the use of crude oil, Mr. Parker states:

"Our pumping is done principally by steam pumps, using crude oil for fuel at 25c per barrel of 42 gals. With this oil

A Derrick for Handling Logs and Timber.

The accompanying engraving shows a special derrick built for the St. Louis Bucket & Box Co., St. Louis, Mo., to handle logs. This derrick has an effective radius of 75 ft., and a capacity of 5 tons; it is supported by steel stiff legs and steel standards. The mast is 60 ft. high. The entire derrick frame is constructed of structural steel. It is operated by three direct current motors of 110 volts capacity.



Special Derrick for Handling Logs.

The hoisting speed is 60 to 120 ft. per minute, the trolley speed is 125 to 150 ft., and the swinging speed one to two revolutions per minute. The gearing is of steel throughout, and the hoist is a type of mechanical screw brake and electric brake. It will be noted that the trolley travels between the latticed girders of the jib. A suitable enclosure is provided for the mechanism and for the operator to give protection from the weather. The derrick was designed and built by the Northern Engineering Works, of Detroit, Mich.

Ossian Guthrie.

The death on October 25 of Ossian Guthrie takes away one of the most noted of the pioneer engineers of the central west. Mr. Guthrie's span of active life had been so long and the work of his later years so much given up to other tasks that many had almost forgotten that it was as an engineer and not as a geologist that the man first made his name known. Of Mr. Guthrie's work as a geologist we shall let those speak who are more familiar than ourselves with the progress of that science. It is with his work as an engineer that engineers are chiefly interested, and this work was in its day a notable one.

Ossian Guthrie was born at Turin, N. Y., in 1826 and was the descendant of an old Scotch family. His grandfather was Dr. Samuel Guthrie of Jefferson County, New York, noted as an original discoverer

of chloroform. Dr. Guthrie's discovery was made in 1831 and independently of the contemporaneous discoveries of Soubeiran and Dumas in France and Liebig in Germany, whose work was unknown to him. The young Ossian showed at an early age the scientific bent of mind inherited from his grandfather, for at 18 he completed a model of a steam engine which upon his coming to Chicago a youth of 20 served as a pattern for the actual steam engine which propelled the first tug boat on the Chicago river.

At about this time the pumping works for supplying water to the Illinois & Michigan canal were being constructed at Bridgeport on the south branch of the Chicago river and now a part of Chicago. Mr. Guthrie was in charge of the construction of the pumping machinery. He later became master mechanic of the pumping plant and then its chief engineer. This work gave Mr. Guthrie the idea which he later suggested to the Citizens' Association of Chicago of draining the Chicago river of its sewage by means of a canal through the summit and to the Desplaines river. In 1885, this plan was put into formal shape by Mr. Guthrie and it was its development that produced the Chicago Main Drainage Channel actually begun some ten years later. Though Mr. Guthrie had no official part in the final construction of the Drainage Canal he worked actively in its support and was enthusiastic for its success.

Incidentally the building of the canal was seized upon by Mr. Guthrie as an aid in the study of glacial geology which he had long before commenced. On this subject he was an enthusiast and he constituted himself the unofficial geologist of Chicago with the utmost devotion to his work. All during the construction of the canal Mr. Guthrie was to be found examining and classifying the geological secrets exposed by the excavations until he became almost as familiar a figure on the work as did

any of the engineers who were directing the actual construction.

Mr. Guthrie was more or less actively engaged in invention all of his life. He developed among other devices machinery for making and preserving ice, various thermometrical apparatus, etc.

Mr. Guthrie was married five times, his last wife being Mrs. Elizabeth P. Flower, who was married to him on July 1, 1907. He is survived by his widow, by a brother, Ward L. Guthrie, and a sister, Mrs. Evelyn Dunn, both of Chicago, and by two half brothers, Dr. Alfred Guthrie of Chicago and Mr. Chan. Guthrie of Waukegan, Ill.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0941. **Boilers.**—The Wickes Boiler Co., West Street Building, New York.

A bulletin telling of the Wickes vertical water tube safety steam boiler, showing by cuts that it possesses many advantages over horizontal and spiral tube boilers. The folder or bulletin is one of a series, all of which will be sent on request.

No. 0942. **Pumps.**—United Iron Works, Second and Jefferson Sts., Oakland, Cal.

A 32-page catalog telling of the Eclipse pumps for irrigation, reclamation and general pumping service. The various styles and sizes of the pumps are shown and tables are given showing the capacities of the various pumps. Suction dredges are also illustrated. Price lists of spare parts for pumps are given.

No. 0943. **Sheet Steel Specialties.**—The General Fireproofing Co., Youngstown, O.

This pamphlet gives full catalog information on metal lath, metal studding, wall ties, metal trim for buildings and metal office furniture. The various articles are finely illustrated and are described. In addition the company's lug bar and pin-connected girder frame reinforcement are described at some length.

No. 0944. **Reinforced Concrete Construction.**—American Concrete Steel Co., Newark, N. J.

This handsome pamphlet of 92 pages illustrates and describes the construction of some half-dozen reinforced concrete buildings of importance and also explains by illustrations, description and specifications the company's several systems of reinforced concrete floor slab construction. Weights, dimensions, etc., are all given and altogether a very useful book regarding the "American" system of fireproofing and reinforced concrete construction has been produced.

No. 0945. **Locomotives.**—The Lima Locomotive & Machine Co., Lima, O.

This is an excellent descriptive catalog of about 80 pages devoted partly to Shay geared locomotives and partly to rod locomotives. Several classes of each type are illustrated and described by tables of dimensions, capacities, etc. In addition there are a number of pages of text describing geared locomotive construction, standard specifications for locomotives and giving formulas and diagrams for computing tractive power and resistance, tables of track materials, etc.

No. 0946. **Steam Pumps.**—A. S. Cameron Steam Pump Works, New York, N. Y.

The typography, illustrations, printing, paper and publishers' work generally is exceptionally fine in this 107-page catalog. The firm makes a very complete line of steam pumps. Each type is described by ample text, and where necessary detail drawings, and the several sizes of each type are each illustrated and have dimensions, capacity, prices, etc., given in tabular form. The book closes with a score or more pages of "useful information" for steam engineers.

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Oct. 28. Sheffield, Ala.....	Oct. 28
Oct. 30. Buffalo, N. Y.....	Oct. 28
Oct. 30. Jacksonville, Fla.....	Oct. 7
Oct. 31. Bryan, O.....	Oct. 21
Oct. 31. Richmond, Ind.....	Oct. 21
Nov. 2. Salem, Ind.....	Oct. 21
Nov. 2. St. Jacques, N. B.....	Oct. 28
Nov. 2. Elgin, N. B.....	Oct. 28
Nov. 2. Alma, N. B.....	Oct. 28
Nov. 2. Zanesville, O.....	Oct. 28
Nov. 2. Lincoln, Neb.....	Oct. 28
Nov. 2. Lirneus, Mo.....	Oct. 28
Nov. 2. Greenfield, Ind.....	Oct. 28
Nov. 3. Centralia, Ill.....	Oct. 28
Nov. 4. Vincennes, Ind.....	Oct. 21
Nov. 4. Princeton, Ind.....	Oct. 21
Nov. 4. Toledo, O.....	Oct. 21
Nov. 4. Fargo, N. Dak.....	Oct. 21
Nov. 4. Rushville, Ind.....	Oct. 28
Nov. 4. Petersburg, Ind.....	Oct. 28
Nov. 4. Indianapolis, Ind.....	Oct. 28
Nov. 5. Austin, Tex.....	Oct. 14
Nov. 6. Tipton, Ind.....	Oct. 21
Nov. 7. Frankfort, Ind.....	Oct. 14
Nov. 9. Los Angeles, Cal.....	Oct. 28
Nov. 9. Grundy Center, Ia.....	Oct. 28
Nov. 10. Fremont, Neb.....	Oct. 28
Nov. 11. Toledo, O.....	Oct. 21
Nov. 11. Cleveland, O.....	Oct. 21
Nov. 11. Whitefish Point, Mich.....	Oct. 28
Nov. 11. Toledo, O.....	Oct. 28
Nov. 12. Charles City, Ia.....	Oct. 21
Nov. 13. Cincinnati, O.....	Oct. 28
Nov. 18. Marianna, Ark.....	Oct. 28
Nov. 20. Beaufort, N. C.....	Oct. 28

Buildings.

Oct. 28. Baltimore, Md.....	Oct. 21
Oct. 28. Otisville, N. Y.....	Oct. 21
Oct. 29. Cambridge, O.....	Oct. 21
Oct. 29. Pittsburg, Pa.....	Oct. 28
Oct. 30. Carthage, Mo.....	Sept. 30
Oct. 30. Honolulu, Hawaii.....	Oct. 14
Nov. 2. Chicago, Ill.....	Oct. 7
Nov. 2. St. Joseph, Mo.....	Oct. 28
Nov. 3. Brunswick, Ga.....	Oct. 14
Nov. 3. Parkhill, Ont.....	Oct. 28
Nov. 3. Leamington, Ont.....	Oct. 28
Nov. 4. North Chicago, Ill.....	Sept. 30
Nov. 4. Marietta, Ga.....	Oct. 7
Nov. 4. Chicago, Ill.....	Oct. 28
Nov. 4. Chicago, Ill.....	Oct. 28
Nov. 5. Cleveland, O.....	Sept. 30
Nov. 5. Winfield, Kan.....	Oct. 7
Nov. 5. Guthrie, Okla.....	Oct. 14
Nov. 5. Sacramento, Cal.....	Oct. 21
Nov. 5. National Soldiers Home, Va.....	Oct. 28
Nov. 5. Baltimore, Md.....	Oct. 28
Nov. 7. Eugene, Ore.....	Oct. 14
Nov. 7. Weehawken, N. J.....	Oct. 21
Nov. 9. St. Paul, Minn.....	Oct. 7
Nov. 10. Toledo, O.....	Oct. 7
Nov. 10. Schenectady, N. Y.....	Oct. 14
Nov. 10. White Plains, N. Y.....	Oct. 21
Nov. 11. Newbern, N. C.....	Oct. 21
Nov. 16. Iola, Kan.....	Oct. 21
Nov. 17. Crookston, Minn.....	Oct. 14
Nov. 18. Fort Hancock, N. J.....	Oct. 28
Nov. 19. Rawlins, Wyo.....	Oct. 14
Nov. 20. Trinidad, Col.....	Oct. 21
Nov. 21. Philadelphia, Pa.....	Oct. 28
Nov. 23. Ship Island, Miss.....	Oct. 28
Nov. 24. Baker City, Ore.....	Oct. 21
Nov. 25. Hazelton, Pa.....	Oct. 28
Nov. 27. Milford, Del.....	Oct. 28
Nov. 30. Manchester, Va.....	Oct. 28
Dec. 1. Newton, Kan.....	Oct. 28
Dec. 2. Carlisle, Pa.....	Oct. 28
Dec. 7. Lebanon, Ind.....	Oct. 28

Roads and Streets.

Oct. 28. Ottawa, Kan.....	Oct. 14
Oct. 28. Brooklyn, N. Y.....	Oct. 21
Oct. 28. Springfield, O.....	Oct. 21
Oct. 29. New York, N. Y.....	Oct. 21
Oct. 29. Harrisburg, Pa.....	Oct. 21
Oct. 30. Pittsburg, Pa.....	Oct. 28
Oct. 31. Greencastle, Ind.....	Oct. 21
Oct. 31. Cleveland, O.....	Oct. 21
Oct. 31. Louisville, Ky.....	Oct. 21
Oct. 31. Lexington, Ky.....	Oct. 28
Oct. 31. East St. Louis, Ill.....	Oct. 28
Nov. 2. Tipton, Ind.....	Oct. 21
Nov. 2. Lebanon, Ind.....	Oct. 21
Nov. 2. Jasper, Ind.....	Oct. 21
Nov. 2. Newport News, Va.....	Oct. 21
Nov. 2. Crown Point, Ind.....	Oct. 21
Nov. 2. Columbus, Ind.....	Oct. 21
Nov. 2. Albany, N. Y.....	Oct. 28
Nov. 2. Hartford City, Md.....	Oct. 28
Nov. 2. Greenfield, Ind.....	Oct. 28
Nov. 4. Monticello, Ind.....	Oct. 21
Nov. 4. Cape May C. H., N. J.....	Oct. 28
Nov. 4. Muncie, Ind.....	Oct. 28
Nov. 4. Corydon, Ind.....	Oct. 28
Nov. 5. Frankfort, Ind.....	Oct. 21
Nov. 5. Kansas City, Mo.....	Oct. 28
Nov. 5. Winamac, Ind.....	Oct. 28
Nov. 6. Cincinnati, O.....	Oct. 21
Nov. 6. Cincinnati, O.....	Oct. 21
Nov. 6. Greenfield, Ind.....	Oct. 21
Nov. 6. Lafayette, Ind.....	Oct. 24
Nov. 7. Crawfordsville, Ind.....	Oct. 21
Nov. 7. Crawfordsville, Ind.....	Oct. 28
Nov. 9. Albany, N. Y.....	Oct. 21
Nov. 9. Ashland, O.....	Oct. 28
Nov. 14. Cleveland, O.....	Oct. 28
Nov. 20. Wabash, Ind.....	Oct. 28

Sewers.

Oct. 28. Rye, N. Y.....	Sept. 30
Oct. 28. Springfield, O.....	Oct. 21
Oct. 28. Columbus, O.....	Oct. 21
Oct. 29. Cleveland, O.....	Oct. 21
Oct. 29. New York, N. Y.....	Oct. 21
Oct. 30. Buffalo, N. Y.....	Oct. 21
Oct. 30. Pittsburg, Pa.....	Oct. 28
Oct. 30. Buffalo, N. Y.....	Oct. 28
Nov. 2. Selma, Cal.....	Oct. 7
Nov. 2. Elizabeth, N. J.....	Oct. 14
Nov. 2. Washington, D. C.....	Oct. 21
Nov. 2. New Cumberland, Pa.....	Oct. 28
Nov. 2. Albany, N. Y.....	Oct. 28
Nov. 4. Wyoming, O.....	Oct. 14
Nov. 4. Appleton, Wis.....	Oct. 28
Nov. 4. Havverstraw, N. Y.....	Oct. 28
Nov. 5. Springfield, O.....	Oct. 28
Nov. 6. Spencer, Ia.....	Oct. 21
Nov. 6. Salt Lake City, Utah.....	Oct. 28
Nov. 7. San Diego, Cal.....	Oct. 21
Nov. 10. South Bend, Ind.....	Oct. 28
Dec. 1. Guayaquil, Ecuador.....	Oct. 7

Water Supply.

Oct. 28. Verona, N. J.....	Sept. 23
Oct. 28. Brooklyn, N. Y.....	Oct. 21
Oct. 28. Brooklyn, N. Y.....	Oct. 21
Oct. 28. Chicago, Ill.....	Oct. 21
Oct. 29. Helena, Mont.....	Oct. 7
Oct. 29. Richmond, Va.....	Oct. 21
Oct. 29. Cincinnati, O.....	Oct. 21
Oct. 30. Passaic, N. J.....	Sept. 16
Nov. 2. Coboes, N. Y.....	Sept. 16
Nov. 3. Mendota, Wis.....	Oct. 21
Nov. 5. Shawnee, O.....	Oct. 28
Nov. 7. Fort Slocum, N. Y.....	Oct. 28
Nov. 10. Kansas City, Mo.....	Oct. 21
Nov. 10. Karksdake, Miss.....	Oct. 28
Nov. 10. Saint Marys, Kan.....	Oct. 28
Nov. 12. Toledo, O.....	Oct. 21
Nov. 12. Gadsden, Ala.....	Oct. 28
Nov. 12. San Diego, Cal.....	Oct. 21
Nov. 16. Hartwell, O.....	Oct. 21
Nov. 23. Wilmington, Del.....	Oct. 21

Miscellaneous.

Oct. 28. New York, N. Y.....	Life Boat, Oct. 14
Oct. 29. Buffalo, Minn.....	Electric Light Plant, Oct. 28
Oct. 30. Brooklyn, N. Y.....	Coal Shed, Oct. 14
Oct. 30. Rondeau, Ont.....	Breakwater, Dredging, Oct. 14
Oct. 30. Pittsburg, Pa.....	Street Lighting, Oct. 28
Oct. 31. Moncton, N. B.....	Railway, Oct. 28
Nov. 2. Washington, D. C.....	Submarines, Aug. 5
Nov. 2. Detroit, Mich.....	Concrete Wharf, Oct. 21
Nov. 3. Port Burwell, Ont.....	Breakwater Extension, Etc., Oct. 14
Nov. 3. Wilmington, Del.....	Removing Wreck, Oct. 21
Nov. 4. Toledo, O.....	Driving Piling, Oct. 28
Nov. 5. Fort Riley, Kan.....	Corral Fences, Oct. 28

Nov. 6. Blue Rocks, N. S.....	Breakwater, Oct. 28
Nov. 10. New York, N. Y.....	Retaining Wall, Oct. 21
Nov. 13. Cape St. Ignace, Que.....	Wharf, Oct. 28
Nov. 14. Charleston, S. C.....	Coal Handling Plant, Oct. 21
Nov. 11. Peterboro, Ont.....	Canal Work, Oct. 28
Nov. 16. Ottawa, Ont.....	Wharf, Pier Extension, Oct. 28
Nov. 17. Mobile, Ala.....	Lock and Dam, Sept. 23
Nov. 17. New York, N. Y.....	Borings, Oct. 28
Nov. 17. Albany, N. Y.....	Canal Work, Oct. 28
Nov. 18. California City Point, Cal.....	Coal Hoisting Tower, Oct. 14
Nov. 18. Fort Myer, Va.....	Fences, Corrals, Oct. 28
Nov. 18. Plattsburg Barracks, N. Y.....	Electric Light System, Oct. 28
Nov. 19. San Francisco, Cal.....	Pier and Shed, Oct. 28
Nov. 20. Mobile, Ala.....	Pump Dredge, Oct. 21
Nov. 28. St. Louis, Mo.....	Dry Dock, Oct. 28

Excavation, Earth and Rock

Oct. 30. Wilmington, Del.....	Dredging, Oct. 14
Oct. 30. Cerro Gordo, Ill.....	Tile Drains, Oct. 21
Oct. 30. Winchester, Ind.....	Ditch Work, Oct. 28
Oct. 31. North Mankato, Minn.....	Dike, Oct. 28
Oct. 31. Clifford, Ind.....	Drain, Oct. 28
Nov. 2. Glenwood, Ia.....	Ditch Work, Oct. 14
Nov. 3. Vicksburg, Miss.....	Levee Work, Oct. 14
Nov. 3. Greenville, Tex.....	Earth Embankment, Oct. 14
Nov. 3. Port Burwell, Ont.....	Dredging, Etc., Oct. 28
Nov. 4. Prophetstown, Ill.....	Ditch Work, Oct. 14
Nov. 4. Alhambra, Cal.....	Drainage Ditch, Oct. 28
Nov. 6. Peru, Ind.....	Ditch Work, Oct. 28
Nov. 9. Eldora, Ia.....	Ditch Work, Oct. 21
Nov. 10. Velasco, Tex.....	Levees, Ditches, Etc., Oct. 21
Nov. 11. Northwood, Ia.....	Drainage Work, Oct. 21
Nov. 11. Estherville, Ia.....	Ditch Work, Oct. 28
Nov. 14. Galveston, Tex.....	Dredging, Oct. 21
Nov. 30. Los Angeles, Cal.....	Ditch Work, Oct. 21
Dec. 1. Hawaii.....	Dredging, Sept. 23

Materials, Machines, Supplies, Tools, Etc.

— Fond du Lac, Wis.....	Portland Cement, Oct. 28
Oct. 28. Fort Sam Houston, Tex.....	Electric Elevator, Oct. 7
Oct. 28. Brooklyn, N. Y.....	Well Drilling Machines, Oct. 21
Oct. 28. Baltimore, Md.....	Fire Department Apparatus, Oct. 21
Oct. 28. Milwaukee, Wis.....	Boiler Plant, Oct. 28
Oct. 29. Richmond, Va.....	Electric Pumping Plant, Oct. 21
Oct. 29. New York, N. Y.....	Road Oil, Oct. 21
Oct. 29. Kansas City, Mo.....	Fire Hose, Oct. 21
Oct. 29. Chicago, Ill.....	Lamp Posts, Oct. 21
Oct. 29. Washington, D. C.....	Ornamental Gates, Oct. 21
Oct. 30. Los Angeles, Cal.....	Steel Mixers, Etc., Oct. 28
Oct. 30. Pittsburg, Pa.....	Metal Filing Cases, Oct. 28
Nov. 2. Chicago, Ill.....	Generators, Pumps, Boilers, Etc., Oct. 7
Nov. 2. Los Angeles, Cal.....	Water Pipe, Oct. 14
Nov. 2. Los Angeles, Cal.....	Valves, Oct. 28
Nov. 2. Sherman, Tex.....	Machinery, Pumps, Oct. 28
Nov. 2. Chicago, Ill.....	Machinery, Oct. 28
Nov. 5. Washington, D. C.....	Tanks, Pipe Covering, Oct. 28
Nov. 7. Washington, D. C.....	Metal Wall Lockers, Oct. 21
Nov. 9. Washington, D. C.....	Tanks, Rails, Etc., Oct. 21

Nov. 10. Tompkinsville, N. Y., Machinery, Oct. 28
 Nov. 11. Washington, D. C., Marble Columns, Oct. 28
 Nov. 16. Washington, D. C., Unloading Cranes, Oct. 28

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Sheffield, Ala.—Until 4 p. m., Oct. 28, by C. E. Comstock, Sr., City Clerk, for construction of a reinforced concrete highway bridge over Terminal railway, in Georgia Ave. Bridge to be flat slab type, 22 ft. 6 ins. wide and 52 ft. 8 ins. long, 4 spans. C. L. Peckinpaugh, City Engineer.

Mariana, Ark.—Until 2 p. m., Nov. 18, by County Court Clerk, for constructing steel highway bridge, 450 ft. long, over L'Aguille River at this place. H. N. Pharr, Engineer, 216 Randolph Bldg., Memphis, Tenn.

Los Angeles, Cal.—Until 2 p. m., Nov. 9, by County Supervisors, C. G. Keyes, Clerk, for labor and material for constructing pile trestle bridge over Los Angeles River at Florence Ave. In San Antonio Road District. Bids are also asked for the construction of a reinforced concrete culvert over Dalton Wash, on Central Ave., in the Azusa Road District.

Grundy Center, Ia.—Until noon, Nov. 9, by E. G. Ensminger, County Auditor, for furnishing county with bridge lumber for 1909.

Centralia, Ill.—Until 7 p. m., Nov. 3, by City Clerk, for material and erecting wooden bridge over Crooked Creek.

Indianapolis, Ind.—Until 10 a. m., Nov. 4, by County Commissioners, for constructing 11 culverts; also for concrete pier for bridges over Big Eagle Creek, on Osterman Road, Wayne Township, and for grading and graveling approaches to bridges over Little Eagle Creek, Wayne Township.

Petersburg, Ind.—Until 2 p. m., Nov. 4, by F. R. Bilderback, County Auditor, for the construction of a steel bridge in Jefferson Township, a steel bridge in Washington Township and three small bridges in Patoka Township.

Greenfield, Ind.—Until 10 a. m., Nov. 2, by Charles H. Tray, County Auditor, for constructing bridge.

Rushville, Ind.—Until 2 p. m., Nov. 4, by Albert L. Winship, County Auditor, for repair of bridges and for bulding grade.

Whitefish Point, Mich.—Until Nov. 11, by Frank House, according to reports, for building bridge over Tahquamenon River.

Linneus, Mo.—Until Nov. 2, by T. L. McMichael, County Surveyor, for constructing 11 bridges.

Beaufort, N. C.—Until noon, Nov. 20, by Capt. Earl I. Brown, U. S. Engrs., Wilmington, N. C., for constructing steel draw-span highway bridge with pile and concrete foundations, on Core Creek, near Beaufort. Official advertisement will be found elsewhere in this issue.

Fremont, Neb.—Until noon, Nov. 10, by Jas. A. Donahue, County Clerk, for construction and erection of superstructures, substructures and approaches of all new bridges and for furnishing materials for same.

Lincoln, Neb.—Until 2 p. m., Nov. 2, by W. L. Dawson, County Clerk, for constructing reinforced concrete culvert on O St.

Buffalo, N. Y.—Until Oct. 30, Francis G. Ward, Commissioner Public Works, for the construction of a temporary foot bridge over the Ohio Basin Slip at Miami St.

Zanesville, O.—Until noon, Nov. 2, by L. E. Brelsford, County Auditor, for constructing concrete abutment at west end of river swing bridge at Phillo.

Cincinnati, O.—Until noon, Nov. 13, by County Commissioners, Fred Drehs, Clerk, for the following county work: Under Specifications No. 820, for concrete bridge on Main St., near Deerfield Road, in Madisonville, Columbia Township.

Toledo, O.—Until 10 a. m., Nov. 11, by County Commissioners, for constructing bridge and abutments over Swan Creek on Road No. 366 in Adams Township.

Alma, N. B.—Until noon, Nov. 2, by John Morrissy, Chief Commissioner, Department Public Works, Fredericton, N. B., for rebuilding Point Wolfe Bridge at Alma.

Elgin, N. B.—Until noon, Nov. 2, by John Morrissy, Chief Commissioner, Department Public Works, Fredericton, N. B., for rebuilding River View Bridge over Pollet River.

St. Jacques, N. B.—Until noon, Nov. 2, by John Morrissy, Chief Commissioner, Department Public Works, Fredericton, N. B., for rebuilding River View Bridge over Pollet River.

partment of Public Works, Fredericton, N. B., for rebuilding Silver Stream Mouth bridge.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Milford, Del.—Until 3 p. m., Nov. 27, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction complete of the U. S. Post Office at Milford, Del.

Chicago, Ill.—Until noon, Nov. 4, by Special Park Commission, A. W. O'Neill, Secretary, Room 501, 200 Randolph St., for the plumbing work at the McCormick Municipal playground.

Chicago, Ill.—Until noon, Nov. 4, by Special Park Commission, A. W. O'Neill, Secretary, Room 501, 200 Randolph St., for the general construction of shelter houses and brick fence posts at the McCormick municipal playground, at Sawyer Ave. and 27th St.

Lebanon, Ind.—Until 1 p. m., Dec. 7, by B. F. Herdrich, County Auditor, for remodeling county jail and equipping cells with locks.

Newton, Kan.—Until 3 p. m., Dec. 1, by James Knox Taylor, Supervising Architect (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. Post Office at Newton.

Baltimore, Md.—Until noon, Nov. 5, by Board of Managers, at Governor's Office, Room 500, Union Trust Bldg., Baltimore, for the construction, labor and materials of brick dormitory cottage, for the Women's Group of the Springfield State Hospital for the Insane of the State of Maryland, near Sykesville. Walter M. Gieske, Architect, Room 606A, Equitable Bldg., Baltimore.

Ship Island, Miss.—Until 3 p. m., Nov. 23, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction of quarters and executive buildings at Gulf Quarantine Station, Ship Island, Miss.

St. Joseph, Mo.—Until 3 p. m., Nov. 2, by James Knox Taylor, Supervising Architect, Washington, D. C., for painting and decorating U. S. Post Office at St. Joseph.

Fort Hancock, N. J.—Until 3 p. m., Nov. 18, by W. J. Hawkins, Constructing Q. M., U. S. A., for new plumbing and construction in Barracks 22, 23, 24 and 25 at this post.

Carlisle, Pa.—Until 3 p. m., Dec. 2, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. Post Office at Carlisle.

Hazleton, Pa.—Until 3 p. m., Nov. 25, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction, including plumbing, gas piping, heating apparatus, electric conduits and wiring, of U. S. Post Office at Hazleton.

Philadelphia, Pa.—Until 11 a. m., Nov. 21, by Bureau Yards and Docks, Navy Department, Washington, D. C., for additions to and alterations in the Naval Hospital Buildings at Philadelphia.

Pittsburg, Pa.—Until 10:30 a. m., Oct. 29, by Edward G. Lang, Director Public Safety, for electric wiring of Penn. Ave. police station. Edward Stotz, Architect, Monongahela Bank Bldg.

Manchester, Va.—Until 3 p. m., Nov. 30, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction complete of the U. S. Post Office at Manchester.

National Soldiers Home, Va.—Until Nov. 5, by John T. Hume, Treasurer, Southern Branch, N. H. D. V., National Soldiers Home, for furnishing material and constructing steel ceilings in governor's quarters and barracks and for installing intercommunicating telephone system in hospital building No. 29, furnishing and installing metal drying rooms in main laundry and hospital laundry.

Leamington, Ont.—Until 4:30 p. m., Nov. 3, by Nap Tessier, Secretary Department Public Works, Ottawa, Ont., for constructing public building at Leamington.

Parkhill, Ont.—Until 4:30 p. m., Nov. 3, by Nap Tessier, Secretary Department Public Works, Ottawa, Ont., for constructing public building at this place.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

East St. Louis, Ill.—Until Oct. 31, by Board Local Improvements, for improvement of 26th St., the work including 1,240 cu. yds.

earth excavation placed in fill; 4,800 cu. yds. earth fill in excess of excavation; 5,790 lin. ft. sandstone curb set on concrete; 10,882 sq. yds. vitrified brick laid on 6 in. concrete; 240 lin. ft. 15-in. vitrified clay drain pipe.

Corydon, Ind.—Until 2 p. m., Nov. 4, by Frank E. Watson, County Auditor, for the construction of a free gravel road or macadamized road in Jackson Township. Also for the construction of a free gravel or macadamized road in Spencer Township.

Crawfordsville, Ind.—Until 10 a. m., Nov. 7, by B. B. Engle, County Auditor, for improvement of public highway.

Greenfield, Ind.—Until 10 a. m., Nov. 2, by Charles H. Tray, County Auditor, for improvement of a gravel road.

Hartford City, Ind.—Until noon, Nov. 2, by L. W. Daugherty, County Auditor, for constructing macadam road.

Lafayette, Ind.—Until 2 p. m., Nov. 6, by J. P. Foreman, County Auditor, for constructing three gravel roads.

Muncie, Ind.—Until 10 a. m., Nov. 4, by Jas. E. Davis, County Auditor, for improvement of 14 highways.

Wabash, Ind.—Until 10 a. m., Nov. 20, by J. P. Nofziger, County Auditor, for grading, draining and graveling public highway.

Winamac, Ind.—Until noon, Nov. 5, by Ellis S. Rees, County Auditor, for improvement and construction of roads.

Lexington, Ky.—Until Oct. 31, by W. M. Bateman, Superintendent Public Works, for constructing concrete sidewalks on portions of four streets.

Kansas City, Mo.—Until 11 a. m., Nov. 5, by J. L. Darnell, City Engineer, for the following works: Constructing creosoted block pavement on 14th St.; remacadamizing parts of Main St. and 15th St.; 15 contracts for constructing asphalt pavement; 6 contracts for constructing brick pavement.

Cape May C. H., N. J.—Until noon, Nov. 4, by Anthony B. Smith, County Road Director, for constructing 2,094 miles of gravel road. R. Fendall Smith, County Engineer, Ocean City, N. J.

Albany, N. Y.—Until 3 p. m., Nov. 2, by Board of Contract and Supply, Isidore Wachsmann, Secretary, for improvement of Sherman St., by grading, curbing and paving the carriageway with vitrified fire clay paving blocks, repairing and laying sidewalks with flags and vitrified blocks and building receiving basins. Bond for \$2,500 required with bid.

Ashland, O.—Until Nov. 9, by Mayor and Village Council, for grading, curbing and paving on Church St. and for constructing sidewalks and grading on Carroll St.

Cleveland, O.—Until 11 a. m., Nov. 14, by County Commissioners, William F. Black, Clerk, for the improvement of Mayfield Road from Warrensville Road easterly to the easterly line of Euclid Township.

Pittsburg, Pa.—Until 10 a. m., Oct. 30, by A. B. Shepherd, Director Public Works, for one contract for grading, curbing and paving with lizonier blockstone, three contracts for grading, curbing and paving with repressed vitrified brick and two contracts for grading, curbing and paving with repressed vitrified brick paving and Hillside repressed vitrified brick paving, class A.

Scottsdale, Pa.—Until 8 p. m., Nov. 6, by Borough Clerk, for paving Arthur Ave., the work including 2,400 cu. yds. grading; 4,900 sq. yds. vitrified brick or block; 3,200 lin. ft. sandstone or concrete curb, and 350 lin. ft. backing stone. J. B. Hogg, Borough Engineer, Connellsville, Pa.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Fort Dodge, Ia.—Until 5 p. m., Nov. 16, by City Clerk, for constructing sanitary sewers in 15th St., 4th Ave. south, 7th Ave. south, 19th St. and in 10th St., in West Fort Dodge.

South Bend, Ind.—Until Nov. 10, by Board Public Works, for constructing sewer in Jefferson and Hine Sts.

Marshall, Ill.—Until Nov. 12, by Board Local Improvements, for constructing about two miles of reinforced concrete and vitrified pipe sewers. Falge & Stock, Engineers, Arcade, Room 103, 116 South 6th St., Terre Haute, Ind.

Clarksdale, Miss.—See under Bids Asked—Water Supply.

Albany, N. Y.—Until 3 p. m., Nov. 2, by Board of Contract and Supply, Isidore Wachsmann, Secretary, for constructing 12-in. sewer in Myrtle Ave. (bond for \$700 with bid) and 12-in. sewer in Morris St. (bond for \$350 with bid).

Buffalo, N. Y.—Until 11 a. m., Oct. 30, by F. G. Ward, Commissioner Public Works, for constructing 12-in. tile sewer in Goemble St., and a similar sewer in Hedley St.

Haverstraw, N. Y.—Until 7:30 p. m., Nov. 4, by Village Trustees, Henry F. Dorl, Clerk, for constructing sewer system, the work including: 2,470 ft. of 36-in. brick or combination concrete and brick sewer; 1,170 ft. of 30-in. brick or combination concrete and brick sewer; 970 ft. of 18-in. double strength vitrified pipe sewer; 2,332 ft. of 15-in. double strength vitrified pipe sewer; 1,832 ft. of 12-in. double strength vitrified pipe sewer; 4,890 ft. of 10-in. double strength vitrified pipe sewer; 37,375 ft. of 8-in. double strength vitrified pipe sewer. Alexander Potter, Consulting Engineer, 143 Liberty St., New York.

Springfield, O.—Until noon, Nov. 5, by Board Public Service, Wm. H. Mahoney, Clerk, for installing sewers in parts of South Fountain Ave., Lagonda Ave., Carr St., Euclid Ave., Pleasant St. and Yellow Springs St. Work includes: 580 ft. of 41-in., 910 ft. of 30-in., 1,110 ft. of 18-in., 1,150 ft. of 15-in., 900 ft. of 12-in., 1,840 ft. of 10-in., 4,662 ft. of 8-in. and 9,384 ft. of 6-in. sewer.

New Cumberland, Pa.—Until 5 p. m., Nov. 2, by M. A. Hoff, Chairman Sewerage Committee, for labor and materials for constructing storm water sewers in 5th St.

Pittsburg, Pa.—Until 10 a. m., Oct. 30, by A. B. Shepherd, Director Public Works, for seven contracts for constructing 8-in. to 15-in. pipe sewers.

Salt Lake City, Utah.—Until 8 p. m., Nov. 6, by Board Public Works, L. C. Kelsey, City Engineer, for constructing Sewer Extension No. 211.

Appleton, Wis.—Until 4 p. m., Nov. 4, by E. L. Williams, City Clerk, for constructing sewer in Harris St.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Gadsden, Ala.—Until noon, Nov. 12, by Mayor J. D. Dunlap, for water works extensions and improvements. Certified check for \$1,000 required with bid.

San Diego, Cal.—Until 10 a. m., Nov. 12, by Board Public Works, F. H. Dixon, Clerk, for constructing reservoir. Estimated cost is \$121,000.

Fort Dodge, Ia.—Until 2 p. m., Nov. 12, by Oakland Cemetery Association, B. R. Canfield, Secretary, for construction of 2,500 gallon steel tank on 75-ft. tower.

Saint Marys, Kan.—Until Nov. 10, by City Clerk, for constructing water works to cost about \$47,000. Burns & McDonnell, Engineers, Kansas City, Mo.

Clarksdale, Miss.—Until 8 p. m., Nov. 10, by M. W. Purnell, City Clerk, for constructing about 1½ miles 8-in. house sewers, ¾ miles 6-in. water mains, including hydrants and valves, also a reservoir about 80 ft. long, 55 ft. wide and 9 ft. deep, with metal shingle roof. Deposit required \$600. Walter G. Kirkpatrick, Engineer, Jackson, Miss.

Fort Slocum (P. O., New Rochelle), N. Y.—Until 11 a. m., Nov. 7, by Capt. Peter Murray, Constructing Q. M., U. S. A., for labor and materials for extending water mains—about 600 ft. of 4-in. pipe.

Shawnee, O.—Until noon, Nov. 5, by Village Clerk, for furnishing and laying about 9,433 ft. of 4, 6 and 8-in. cast iron water pipe with valves, hydrants, etc. Bradbury & Shute, Engineers, Hayden Bldg., Columbus, O. Official advertisement will be found elsewhere in this issue.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Alhambra, Cal.—Drainage Ditch.—Until 7:30 p. m., Nov. 4, by Trustees East San Gabriel Levee District, Q. A. Lobingier, Clerk, for constructing drainage ditch, two miles long and 40 ft. wide.

Estherville, Ia.—Ditch Work.—Until Nov. 11, by County Auditor, for constructing Ditch No. 16, requiring 7,800 cu. yds. excavation.

Rockwell City, Ia.—Drain.—Until noon, Nov. 6, by County Auditor, for constructing Drain 97, consisting of 3,600 ft. 16-in., 1,500 ft. 14-in., 1,000 ft. 12-in. and 600 ft. 8-in. tile.

Clifford, Ind.—Drain.—Until 2 p. m., Oct. 31, by J. S. Foust, Commissioner, for construction of change in drain in Flatrock Township.

Peru, Ind.—Ditch Work.—Until 2 p. m., Nov. 6, by David Kercha, County Commis-

sioner of Drainage, for constructing ditch and branches in Perry Township.

Winchester, Ind.—Ditch Work.—Until 10:30 a. m., Oct. 30, by A. L. Wright, Commissioner, at office of County Surveyor, for the construction and furnishing materials for a ditch in Washington Township.

North Mankato (P. O. Mankato), Minn.—Dike.—Until Oct. 31, by C. A. Kene, Village Recorder, for constructing dike.

Port Burwell, Ont.—Dredging, Etc.—Until 4:30 p. m., Nov. 3, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for extension to breakwater and dredging.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

San Francisco, Cal.—Pier and Shed.—Until 9:15 a. m., Nov. 19, by State Harbor Commissioners, W. B. Thorpe, Secretary, for labor and materials (except cement, creosoted mooring piles and track rails with fish plates) for the construction of a pier and shed over same, at foot of First and Townsend Sts. The materials to be used in this work will consist of the requisite quantities of fresh cut, close grained Douglas yellow fir piles, creosoted piles, merchantable yellow fir lumber, staves for cylinders, band iron, Portland cement, sand, crushed rock, reinforcing material, castings, steel I-beams, steel plates and angles, bolts, rivets and spikes, car springs, steel rails and fastenings, asphalt, paving brick, glass, window frames, rolling steel shutters, etc.

Fort Riley, Kan.—Corral Fences.—Until 10 a. m., Nov. 5, by Capt. W. M. Whitman, Constructing Q. M., for construction of corral fences and gates.

Buffalo, Minn.—Electric Light Plant.—Until 8 p. m., Oct. 29, by H. C. West, Village Recorder, for the installation of electrical apparatus and construction material for pole lines and wiring.

St. Louis, Mo.—Dry Dock.—Until noon, Nov. 28, by Capt. G. R. Lukesh, U. S. Engrs., Secretary Mississippi River Commission, Liggett Bldg., St. Louis, for constructing side haul railway dry dock.

Albany, N. Y.—Canal Work.—Until noon, Nov. 17, by F. C. Stevens, Superintendent of Public Works, for Contract No. 40 and Contract No. 46, and until noon, Nov. 18, for Contract No. 41, Contract No. 47 and Contract No. 68, New York State Barge Canal. The work is as follows: Contract No. 40, Erie Canal, Section 10—For the improvement of the Erie Canal from Lockport to Sulphur Springs Guard Lock. Length, 4.84 miles. Contract No. 41, Erie Canal, Section 9—For building embankments at Irondequoit Creek Crossing. Length, about 0.8 mile. Contract No. 46, Erie Canal, Section 7—For the construction of the canal from Fox Ridge to the southeast corner of the town of Galen. Length, 9.44 miles. Contract No. 47, Erie Canal, Section 8—For the construction of the canal from the southeast corner of the town of Galen to a point near the N. Y. C. & H. R. R. crossing at Lyons. Length, 14.46 miles. Contract No. 68, Champlain Canal, Section 1—For constructing in the Hudson River, Lock No. 3 at Mechanicsville; Lock No. 4 at Stillwater, and Lock No. 5 at Northumberland, together with accompanying land construction. Length, about 1.4 miles.

New York, N. Y.—Borings.—Until 11 a. m., Nov. 17, by Board of Water Supply, Thomas Hassett, Secretary, 299 Broadway, for making borings along one or more lines south of Hill View Reservoir, lying mainly in the boroughs of the Bronx, Manhattan and Brooklyn, including lines crossing the Harlem River, probably between 7th Ave. and Washington Bridge and the East River, approximately between the Williamsburg and Brooklyn bridges. Certified check for \$3,000 required with bid.

Plattsburg Barracks (P. O., Plattsburg), N. Y.—Electric Light System.—Until 10 a. m., Nov. 18, by Constructing Q. M., for the construction of transformer sub-station, for furnishing electric current, and for construction of electric lighting system at this post.

Toledo, O.—Driving Piling.—Until noon, Nov. 4, by Board Public Service, Reynold Voit, Secretary, for material and driving piling at the intake crib of water works pumping station. Certified check for \$100 required with bid.

Pittsburg, Pa.—Street Lighting.—Until 10 a. m., Oct. 30, by A. B. Shepherd, Director Public Works, for furnishing incandescent mantle lights to the city on its streets, boulevards, alleys, bridges, byways and parks, for one, two and three years.

Fort Myer, Va.—Fences, Corrals.—Until 11 a. m., Nov. 18, by Capt. B. B. Hyer, Con-

structing Q. M., U. S. A., for construction of fences and corrals for artillery stables at Fort Myer. Official advertisement will be found elsewhere in this issue.

Moncton, N. B.—Railway.—Until Oct. 31, by D. Pottinger, General Manager, for the construction of a line of railway from Harmony Station, on the P. E. I. Railway, to Elmira, a distance of about ten miles.

Blue Rocks, N. S.—Breakwater.—Until 4:30 p. m., Nov. 6, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for constructing breakwater at Blue Rocks.

Ottawa, Ont.—Wharf, Pier Extension.—Until Nov. 16, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for constructing wharf at Pointe a Brousseau, Que.; also for construction of an extension to head block of pier at Riviere Blanche, Que.

Peterboro, Ont.—Canal Work.—Until 4 p. m., Nov. 17, by L. K. Jones, Secretary Department of Railways and Canals, Ottawa, Ont., for constructing the Lindsay Section of the Trent Canal. Plans, etc., with Chief Engineer at Ottawa and at office of Superintending Engineer, Trent Canal, Peterboro.

Cap St. Ignace, Que.—Wharf.—Until 4:30 p. m., Nov. 13, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for constructing wharf here.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Los Angeles, Cal.—Valves.—Until 3 p. m., Nov. 2, by Water Commissioners, 410 South Hill St., for furnishing 339 hub end gate valves and gate caps.

Los Angeles, Cal.—Steel, Mixers, Etc.—Until Oct. 30, by Board of Works, for furnishing a quantity of reinforcing steel; also for furnishing electric hoists, air receivers, reinforcing steel, concrete mixers, tunnel cars, rails and splice bars for the Aqueduct construction. Plans, etc., with Bureau of the Los Angeles Aqueduct, 1102 Central Bldg.

Washington, D. C.—Unloading Cranes.—Until 10:30 a. m., Nov. 16, by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing three rapid unloading cranes—Circular 475. Official advertisement will be found elsewhere in this issue.

Washington, D. C.—Tanks, Pipe Covering.—Until 2 p. m., Nov. 5, by Bernard R. Green, Superintendent of Construction, office of building for National Museum, Library of Congress, for furnishing and delivering the pressure, feed heater, blow-off and oil tanks, one of each, and for the non-conducting pipe covering required for the new building for the National Museum.

Washington, D. C.—Marble Columns.—Until 2 p. m., Nov. 11, by Bernard R. Green, Superintendent of Construction, office of building for National Museum, Library of Congress, Washington, D. C., for furnishing and delivering "Breccia Stazzima" marble column shafts required for the screens in the rotunda of the new building for the National Museum.

Chicago, Ill.—Machinery.—Until 11 a. m., Nov. 2, by Department Public Works, Room 705, No. 200 Randolph St., for the coal and ashes machinery required in connection with the construction of the new City Hall building.

Tompkinsville, N. Y.—Machinery.—Until Nov. 10, by Light House Engineer, for furnishing and installing machinery in new lamp shop of U. S. Lighthouse Depot at Tompkinsville.

Pittsburg, Pa.—Metal Filing Cases.—Until 10 a. m., Oct. 30, by A. B. Shepherd, Director Public Works, for furnishing, erecting and adjusting metal filing cases for Bureau of Water.

Sherman, Tex.—Machinery, Pumps.—Until 7:30 p. m., Nov. 2, by Henry Zimmerman, City Secretary, for certain electrical machinery and deep well pumps. P. C. Thurmond, City Engineer.

Fond Du Lac, Wis.—Portland Cement.—Adjustable Steel Centering Co., Fond Du Lac, Wis., want to be quoted prices immediately on about 240 bbls. Portland cement, f. o. b. Fond Du Lac, for November shipment.

CONTRACTS LET.

The following contracts have been let recently:

Mobile, Ala.—Church.—Jett Brothers Contracting Co., Mobile, for the erection of the St. Francis St. Baptist Church.

Harrisburg, Ark.—Bridge.—J. E. Clanton, Tyrone, Ark., at \$9,500, for constructing

steel bridge over St. Francis River at Marked Tree.

Downsville, Cal.—Bridges.—Western Bridge & Construction Co., at \$3,950, for steel bridge over Little Truckee, and at \$3,875 for bridge in Downsville for county.

Los Angeles, Cal.—Paving.—Fairchild, Gilmore & Wilton Co., at \$13,000, for paving South Main St. with asphalt.

San Francisco, Cal.—Fire Cisterns.—C. Coghill, at \$6,600, for constructing two fire cisterns; Keystone Construction Co., at \$10,338, for constructing three cisterns.

San Francisco, Cal.—Sewer.—City Street Improvement Co., at \$21,938, for laying sewer in Fulton and Divisadero Sts.

Burlington, Colo.—Water Works.—Des Moines bridge & Iron Works, Des Moines, Ia., for installing water works for this city.

Des Moines, Ia.—Laterals.—North Side Plumbing Co. and Edward Cutler, for sewer laterals on Harrison Ave. and 16th St.

Hartley, Ia.—Electric Light Plant.—Westinghouse Co., for electrical apparatus; to the Minneapolis Steel & Machine Co., of Minneapolis, for an 80-hp. gas producer engine, and the Electric Construction Co., Sioux Falls, to place the poles and wires for the electric light system.

Bloomington, Ill.—Sewer.—D. H. Rider, at \$2,617, for constructing sewer in Madison St.

Cairo, Ill.—Sewers.—Board Local Improvements has awarded following sewer contracts: City Construction Co., St. Louis, Mo., at following bid for constructing vitrified pipe sewers: 29th St., \$3,251; 30th St., \$3,449; 31st St., \$3,561; 32d St., \$3,379; 33d St., \$1,951.

Decatur, Ill.—Sewers.—Geo. B. Tuttle, at \$5,825, for constructing two sewers.

Franklin Grove, Ill.—Water Mains.—B. F. Sheets & Son, Oregon, Ill., for laying water mains for village.

Ottawa, Ill.—Bridge.—A. M. Elodgett Construction Co., Kansas City, Kan., at \$19,559, for sub-structure work, including the razing of the old bridge and the concrete masonry work on the piers and abutments, for bridge at this place. The contract for the steel superstructure was awarded to Modern Steel Structural Co., of Waukesha, Wis., at \$63,490.

Marshall, Ill.—Sewer System.—Mercantile Bridge & Concrete Tile Co., Paris, Ill., at \$17,000, for installing sanitary sewer system for this place.

Peoria, Ill.—Bridge.—Missouri Bridge & Iron Co., at \$3,293, for bridge in town of Chillicothe. Bridge is to be of steel and iron, 80 ft. long, main span 16 ft. roadway of 3-in. oak floor with a 34-ft. approach of like roadway floor, resting on concrete masonry abutments with wings and on two steel tubes.

Peoria, Ill.—Bridges.—Schmitt Construction Co., at \$1,778, for constructing bridge in Elmwood, to be of steel and iron, 50-ft. long span, with 14-ft. roadway and 3-in. oak floor resting on two concrete masonry abutments with four wings, Missouri Bridge & Iron Co., St. Louis, Mo., at \$1,000, was awarded contract for bridge over La Marsh Creek.

Chicago, Ill.—Concrete Piles.—D. H. Perkins, Architect of the Chicago Board of Education, has awarded the Raymond Concrete Pile Co. of New York and Chicago the contract for placing Raymond concrete piles in the foundations of the Bowen School at South Chicago.

Quincy, Ill.—Sewer.—Peter Simons, at \$1,195, for sewer in 7th St.

Rockford, Ill.—Paving.—Standard Paving Co., Chicago, Ill., at \$49,339, for paving on East Side and West Side.

Rockford, Ill.—Sewer.—G. Mamoti, at \$2,000, for sewer in Gardner Ave.

Rockford, Ill.—Power Plant.—Rockford Concrete Construction Co., to build new plant and to make improvements to the Rockford Electric Co. at its power station on east side of the river.

Springfield, Ill.—Sewer.—Henry Nelch Contracting Co., at following bid, for constructing south end sewer: Per lin. ft., sewer, 4 ft. deep, \$3.35; 2-in. outlet, per lin. ft., \$0.50; manholes, \$30 each. The total cost of the improvement will be \$20,000.

Franklin, Ind.—Bridges.—W. C. Halstead & Co., Indianapolis, Ind., at \$1,200, for three bridges for county.

Indianapolis, Ind.—Paving, Sewer.—Woodlawn Ave., with brick roadway and curb, American Construction Co.; 25th St., with cement walks, Wm. H. Holt; main drain in Sherman St., 510 ft., R. F. Perkins, at \$3.79 per lin. ft.

Louisville, Ky.—Sewer Work.—Henry Bickel Construction Co., at \$12,000, for constructing sewer in Breckinridge St.; Herr & Raf-

tus, Columbus, O., at \$7,000, for sewer in Green St.

Elwood, Kan.—Pile Work.—Capt. Edward H. Schulz, U. S. Engrs., has awarded the Raymond Concrete Pile Co., of New York and Chicago, contract for placing reinforced concrete piles in the Missouri River, near Elwood, Kans. These piles will be used for holding revetments in some river improvement work that is being carried out there.

Houma, La.—School House.—Caldwell Bros., for construction of Terrebonne high school building.

Boston, Mass.—Paving Work.—John I. Fitzgerald, 8 Bridge Court, for repaving on Scollay Sq. and Bromfield St.

Detroit, Mich.—Church.—Henry Carew, for new brick church for St. Louis Roman Catholic congregation; to cost \$80,000. H. J. Hill is architect.

Detroit, Mich.—Sewer.—John Ginzl Co., for Campbell Ave. sewer and outlet.

Escanaba, Mich.—Postoffice.—Heag & Hoffman, Appleton, Wis., for U. S. Postoffice here.

Grand Rapids, Mich.—Theatre.—M. D. Morgan, for new \$14,000 theatre on North Market St.

Hillsdale, Mich.—Sewer.—Shoecraft & Swoon, Coldwater, Mich., at \$4,590, for "South-East" sewer work.

Chisholm, Minn.—City Hall.—Radcliffe & Price, Duluth, Minn., for erecting city hall for this city.

Minneapolis, Minn.—Theatre.—M. McMillan, to erect the superstructure of the theatre building at 14 4th St. for the S. H. Chute Co.

Riverhead, L. I.—Muralt & Co., of New York, have secured the contract for the enlargement and improvement of the hydro-electric plant of the Riverhead Electric Co., of Riverhead, L. I.

St. Paul, Minn.—Sewer.—O'Neil & Preston, at \$1,314, for sewer in York St.

Two Harbors, Minn.—Sewer.—Thomas & McCoy, Duluth, Minn., at \$2,537, for main sewer in Spruce St.

St. Louis, Mo.—Paving.—Board Public Improvements has awarded following contracts for street improvements: North Dakota, between Compton and Virginia, Ruecking Construction Co., \$3,749; Penrose, between Fair and Newstead, Granite Bituminous Paving Co., \$26,438; Red Bud, between Penrose and Florissant, same, \$23,108; Shawmut Place, between Julian and Wells, same, \$23,060; Temple Place, between Minerva and Wells, same, \$1,193; Ridge, between Hamilton and Hodiament, same, \$11,726; Lawrence, between Magnolia and Shaw, same, \$31,943.

Butte, Mont.—Grading, Sewer.—Jesse Hudleston, for grading of Excelesior from Antimony to Waukesha at 22 cts. per cu. yd. for excavation and 33 cts. for embankment. M. Bardsen, at \$1,350, for two sewers.

Bridgeton, N. J.—Post Office.—W. F. Holden Co., New York, for erection of U. S. Post Office building here.

Trenton, N. J.—City Hall.—James G. Doak & Co., Philadelphia, Pa., for constructing new City Hall.

New York, N. Y.—Concrete Piles.—The Raymond Concrete Pile Co., of New York and Chicago, for placing Raymond concrete piles in the foundations of the new Metropolitan car barns that are to be erected at 54th St. and 9th Ave., New York.

Rochester, N. Y.—Outlet Sewer.—F. C. Lauer & Sons Co., at \$20,075, for constructing outlet sewer in North Water St.

Rochester, N. Y.—Paving, Sewer.—Whitmore, Rauber & Vicinus, at \$8,028, for asphalt pavement on Westminster Road; Julius Friedrichs & Co., at \$2,171, for sewer and walks on Randolph St.

Cincinnati, O.—Fire Engine House.—F. Beckman & Sons, for erection of new engine house at Maple and Circle Aves.

Lisbon, O.—Bridges.—Central Concrete & Construction Co., Canton, O., for erecting five county bridges, as follows: Bridge at Fredericktown, \$687, two in Salineville to cost \$773 and \$319, one in Madison Township to cost \$360, and one in New Waterford to cost \$504.

Mansfield, O.—Pike Road.—Carroll & Gruber, Caledonia, O., at \$17,778, for constructing 3 1/4 miles of pike road.

Reading (P. O. Cincinnati), O.—Water Mains.—John Ryan, at \$1,600, for extending water mains for village.

Youngstown, O.—Warehouse.—John Link, for erecting 3-story brick and stone warehouse, 85x43 ft., for Albert Buehrle, Miller & Ford, Architects.

Warren, O.—Power Line.—H. J. Poff, to erect poles and string high tension wires

from power plant in Newton Falls to this city for Hydro-Electric Co. About 500 poles will be erected and three wires strung. Benj. Ballus has contract for erecting brick, 47x52 ft., power station.

Dewey, Okla.—School House.—J. B. Brewster, Coffeyville, Kan., for erecting new high school building here.

Sayre, Okla.—Building.—W. K. Rice, at \$21,110, for new school building.

Astoria, Ore.—Reservoir.—Palmberg, Gooding & Mattson, Portland, Ore., for construction of 20,000,000 gallon reservoir for city.

Portland, Ore.—Electric Plant.—The contracting engineering office of Edwin G. Amme has been awarded the contract for the installation of the 600-hp. hydro-electric plant of the Three Sisters Mining & Milling Co.

Elizabeth, Pa.—Sewers.—James Nixon for sewerage the Pittsburgh-Buffalo Coal Co.'s new town of Marianna, in Washington County. Work includes about two miles of sewers.

Lebanon, Pa.—Bridge.—Nashville Bridge Co., Nashville, Tenn., for two steel bridges for county, to cost about \$2,000 each.

North East, Pa.—Sewers.—William Simpson for installing sewer; work is to be completed by Dec. 15.

Philadelphia, Pa.—Coal Pocket.—The William Steele & Sons Co., for a coal pocket at the northeast corner of 10th and Norris Sts., to cost \$34,000, for Reading Ry. The buildings will all be of concrete and will consist of a 20-ft. trestle, a shed, stable and office.

Watsontown, Pa.—Sewers.—Corvett Construction Co., Williamsport, Pa., for extension of town sewer system.

El Paso, Tex.—High School.—T. R. Francis for erection of new school in Mundry Heights.

Logan, Utah.—Bridge.—M. E. Idle of Midland Bridge Co., at \$5,590, for constructing steel bridge over Bear River; 110-ft. span, 16-ft. roadway.

Fond du Lac, Wis.—Sewer.—Chris Johnson, Oshkosh, Wis., at \$1,828, for sewer in North Main St.

Cumberland, Wis.—Water Works.—J. G. Robertson, St. Paul, Minn., for installing water works for city.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States.

Arkadelphia, Ark.—County Court has appropriated \$1,500 for constructing two bridges over Cadda River.

Batesville, Ark.—County Court has decided to build five steel bridges.

Bentonville, Ark.—County Court has provided for building bridge over the Spavinaw between Gravette and Decatur.

Mena, Ark.—An appropriation of \$9,000 has been made by County for constructing three steel bridges.

Paris, Ark.—County Court has made appropriation for building steel bridge over Scott's Creek, and for completion of steel bridge over Petit Jean River.

Fresno, Cal.—County Supervisors have directed County Surveyor McKay to prepare plans and specifications for a \$5,000 bridge to be erected at Reedley.

San Francisco, Cal.—M. Marston, City Engineer, is to prepare plans and estimates of cost for the Mission Ave. viaduct.

Visalia, Cal.—County Supervisors are receiving plans and specifications for a steel or wood bridge to be erected over Kings River, near Traver.

Des Moines, Ia.—C. R. I. & P. Ry., C. B. & Q. Ry. and M. & St. L. Ry. have submitted proposition to city for the construction of a viaduct over and across the railroad tracks in West Des Moines. A. J. Mathis is Mayor.

Marshalltown, Ia.—City Council is considering building concrete bridge on 13th St.

Cambridge, Ill.—A. N. Johnson, State Engineer, Springfield, Ill., is to make estimates of cost for the erection of two bridges over Rock River for Henry and Rock Island Counties.

Princeton, Ind.—County Commissioners rejected all bids received Oct. 12, for building and repairing 30 county bridges and new bids will be called for. The Vincennes Bridge Co., at about \$13,000, was low bidder.

Carlisle, Ky.—Local parties are to form company for the purpose of building a toll bridge over Licking River at Parks Ferry

Franchise has been asked of County Fiscal Court.

Baltimore, Md.—Harbor Engineer Lackey is planning to rebuild Pratt St. bridge over Jones' Falls 120 ft. wide to conform with the width of Pratt St. west of the falls. The bridge is now 80 ft. wide.

Takoma Park, Md. (P. O., Washington, D. C.)—Village Council has approved plans and specifications for steel and concrete bridge to be erected over Sligo Stream and bids will be asked at once. W. G. Platt is Mayor. W. J. Douglass, Washington, D. C., is Consulting Engineer. Bridge will be 250 ft. long and 16 ft. wide.

Detroit, Mich.—City proposes to issue \$1,300,000 of bonds for constructing Belle Isle Bridge.

Lansing, Mich.—City Engineer is to prepare plans and specifications for concrete and steel, single span, 40 ft. wide, bridge, to be erected over Cedar River at Cedar St.

Owosso, Mich.—City will vote Nov. 3 on giving \$2,500 toward a bridge to be built over the river here by the Ann Arbor R. R. J. Wanbecq is Resident Engineer, A. A. R. R., Toledo, O.

St. Louis, Mo.—A. J. O'Reilly, President Board Public Improvements, has submitted to the Board plans and specifications for the piers for the municipal free bridge to be erected at Chouteau Ave. Ordinance will be submitted to Municipal Assembly and contract can then be let for the piers, which will cost about \$666,277. According to the estimates the work will include: Excavation for caissons, 26,865 cu. yds., caissons and cribs, 21,345 cu. yds.; cut limestone to face masonry, including backing, 19,636 cu. yds., granite coping stones, 207 cu. yds., granite nosing stones, 151 cu. yds., limestone belting courses, including backing, 498 cu. yds., limestone coping, 310 cu. yds. About \$2,000,000 has been allotted for the construction of the bridge and a bill is now before the Municipal Assembly to authorize the employment of engineers for the work.

Missoula, Mont.—Waddell & Harrington, Kansas City, Mo., have been employed by County Commissioners to prepare plans for the Higgins Ave. bridge. County has set aside \$135,000 for its construction.

Bridgeport, N. Y.—Towns of Cicero and Sullivan will vote Nov. 3 on spending \$9,000 for new bridge over Chittenango Creek at Bridgeport.

Cincinnati, O.—Norfolk & Western R. R., J. E. Crawford, Bridge Engineer, Roanoke, Va., proposes to construct steel bridge at Ferris Ave., Hyde Park, to replace present wooden structure.

Cincinnati, O.—Ordinance is before Council to appropriate \$50,000 for repairing and reconstructing Liberty St. viaduct.

Zanesville, O.—Ordinance is before Council that the city engineer be instructed to prepare plans and the estimate of the cost of constructing a bridge over the C. & M. V. tracks from Maysville Ave. at the entrance of Epley Ave.

Pittsburg, Pa.—New Liberty Bridge Co. has been chartered, with capital stock of \$5,000, and proposes to build a span across the Monongahela River, from a point in the 6th Ward, 526 ft. east of the Pennsylvania R. R. bridge, straight across to the southerly side of Manor St., 30th Ward. The bridge is connected with a tunnel system on the South Side. John F. and P. H. Mueller and Adolph Stedwig, the incorporators, have plans to put two tunnels through Mt. Washington.

Philadelphia, Pa.—Millard Construction Co., at \$27,000, was low bidder Oct. 14 for the construction of a reinforced concrete bridge with a span of 70 ft. on the line of Fox St. over the Richmond branch of the Reading Ry. for the city.

Fort Worth, Tex.—City Council is considering widening 7th St. bridge an additional 20 ft.

Railroads.

Items Arranged Alphabetically by States.

Oroville, Cal.—Western Pacific Ry., according to reports, will make this city a division point and will erect shops and round house here. The shops and yard according to the report will cover 75 acres and there will be 30 miles of track in the yard. A 30-stall round house will also be built. E. Oliver, Oroville, is Division Engineer.

Denver, Colo.—Officials of the Colorado & Southern Ry., H. W. Cowan, Chief Engineer, Denver, have been inspecting south of the branch line which the company proposes to build from Pueblo to Walsenburg. The company has completed its surveys and advices from this city state that work may be

started early in the year. The company is also planning an extension from Wellington to Cheyenne, Wyo.

Tampa, Fla.—Seaboard Air Line Ry., W. L. Seddon, Chief Engineer, Portsmouth, Va., is stated to have purchased 2,500 M. ft. B. M. of lumber to be used in terminal construction work at Grassy Island.

Weiser, Idaho.—Oregon Midland Ry. Co., incorporated with capital stock of \$100,000, has filed its articles of incorporation at Salem, Ore. The company proposes to build a line from this city to the Tillamook Bay country in Oregon, touching at Salem. The incorporators are C. M. Conry, Miller Murdoch and Robert Caples of Portland, and John P. Van Orsdel, a civil engineer.

Owosso, Mich.—New Haven Coal Mining Co. has been granted franchise by City Council to enter city with a steam railroad from the company's mines, six miles north. Land for a terminal has been purchased here and the road will be finished this winter. City will vote Nov. 3 on giving company \$2,500 towards the building of a bridge so that the road can get into the city. The bridge will be built by the Ann Arbor R. R., it is said. Jos. Wanbecq, Toledo, O., is Engineer, Ann Arbor R. R.

Deer River, Minn.—Minneapolis & Rainy River Ry. Co., of Minneapolis, F. A. Bill, Secretary, has increased its capital stock from \$1,000,000 to \$2,000,000. S. D. Patrick, Deer River, is Chief Engineer.

Crow Wing, Minn.—Cayuna Iron Range Ry. Co. has been incorporated with a capital stock of \$100,000, and proposes to construct a line of railway from Crow Wing, Crow Wing County, easterly to Douglas County, Wisconsin, thence to Superior. The incorporators are: Kuyler Adams, Deerwood, Minn.; H. D. Fryberger, Duluth, and H. C. Fulton, Duluth.

St. Paul, Minn.—St. Paul Bridge & Terminal Co., incorporated with capital stock of 500,000, proposes to construct 2½ miles of railway, including a steel draw bridge over the river. The bridge will be about 800 ft. long. The projected line will be used for hauling live stock for the terminals at Dayton Bluff to the South St. Paul Yards. The Union Stock Yard Co. is interested. L. F. Swift is President, William Magivny is Vice President, Alexander McKechnie Secretary and Treasurer, and Joseph Strawhorn General Manager.

Natchez, Miss.—Chamber of Commerce has appointed committee to secure subscriptions for the proposed railway from Meridian to Natchez. Surveys for the road are reported under way.

Raleigh, N. C.—Boulee & Western R. R. Co. has been chartered with capital stock of \$150,000 and proposes to construct a railroad through Chatham and Randolph Counties—14 miles, from Causey, Chatham County, to a point on Deer River in Randolph County. The incorporators are: J. H. Dunlap, Charles Burnes, C. M. Andrews, W. T. Brooks, J. H. Kneedy and C. C. Burns.

Albuquerque, N. Mex.—Dominion Construction Co., which has contract for building the extension of the New Mexico Central Ry. to this city, is stated to have opened offices in this city preliminary to beginning work on its contract. The construction plant of the company is now in the Estancia Valley.

El Reno, Okla.—Fort Smith & Western R. R., W. M. Bushnell, General Manager, Fort Smith, Ark., according to advices from this city, has decided to begin construction on its extension southwest to the Red River.

Guthrie, Okla.—Oklahoma, Mexico & Pacific Ry. Co. has filed an amended charter by which a change of route is made, leaving out Kiowa and Greer Counties. The road as now proposed is to start at Oklahoma City, building in a northwesterly direction through Oklahoma, Canadian, Caddo, Washita, Custer, Dewey, Ellis, Woodward, Beaver, Texas and Cimarron Counties to Kenton in the last named county. A branch is also contemplated from Oklahoma City through Grady County.

Memphis, Tenn.—It is reported here that construction of the Gulf & Magnolia Northern R. R., which recently secured a charter under the laws of Arkansas, will be started by the first of the year. The line will be 40 miles in length and will run from Hope, Ark., to Magnolia, passing through Hempstead, Nevada and Columbia Counties. The road, which is virtually an extension of the Louisiana & Arkansas, will make connection with both the St. Louis, Iron Mountain & Southern and the Rock Island system at Hope, while connection will be made with the St. Louis, Southwestern at Waldo and with the Louisiana & Northwestern at Magnolia.

Cleburne, Tex.—Active operations are to be taken up soon, it is said, for building a railroad from Dallas to Hamilton via Egan and Cleburne. The project is being promoted by

W. A. McDonald, Secretary-Treasurer of the Dallas, Cleburne & Southwestern Ry. Co.

Electric Railways.

Items Arranged Alphabetically by States.

Heber, Ark.—City Council has granted franchise for electric light system and street railway to W. H. Horton and C. F. Crosby.

Berkeley, Cal.—City Council has granted franchise to Key Route R. R. for the use of Sacramento St. for its electric railway.

Hanford, Cal.—Fresno, Hanford & Summit Lake Interurban Ry. Co. has been chartered with an authorized capital stock of \$1,000,000. The company proposes to construct 60 miles of road between Hanford, Grangeville and Lemoore in Kings County and Fresno, Malaga, Fowler, Selma, Kingsburg and Linton in Fresno County. The principal place of business will be at Hanford. The company has been promoted by F. S. Granger, Hanford, who is the principal stockholder, and secured most of the franchises. L. A. Nares, Fresno, Cal., is President.

Marysville, Cal.—Advices from this city state that work is to be started here early next month on the construction of the California Midland Ry. to Hammononton.

San Francisco, Cal.—The Fillmore Street Improvement Co. has offered to contribute \$42,500 toward the building of an electric line along Gough St., from Market to McAllister Sts.

San Rafael, Cal.—Charles Murphy, Corte Madera, Cal., has applied to County Supervisors for a franchise to run an electric road on the County roads of southern Marin County. The proposed road would be operated by an overhead trolley and extend from Sausalito to Mill Valley, Belvedere and San Rafael.

Santa Ana, Cal.—Pacific Electric Co. has secured right of way from Talbert to Huntington Beach for its proposed electric railway from this city to the latter place.

Ventura, Cal.—Ventura & Los Angeles Terminal Ry. Co. has secured franchise for electric railway from Main St. in this city down Oak to Meta, thence to Olive, to Park Row, to Ventura Ave. and to the cement quarry in the Matilija canyon, a distance of about 5 miles.

St. Libory, Ill.—With principal offices in this place and capital stock of \$100,000, the St. Louis & St. Libory R. R. Co. has been incorporated. The incorporators are: E. L. Thomas, John T. Taylor, D. O. Thomas, C. A. Heinzelmann and Gustave A. Becker.

Rantoul, Ill.—W. I. Moore, Kankakee, Ill., is making preliminary surveys for an interurban railroad from Urbana to Rantoul and thence north to Kankakee. The surveys are being made for the Chicago, Kankakee & Champaign Ry. Co., of Kankakee.

Taylorville, Ill.—W. B. Adams, Taylorville, is promoting a project for an interurban line from this city to Nokomis.

Terre Haute, Ind.—Terre Haute, Indianapolis & Eastern Traction Co. has planned to build a spur line to run from Shelburn, six miles north of Sullivan, to Hymera, six miles east of Shelburn. The spur is to pass through several villages.

Battle Creek, Mich.—Michigan United Rys. has asked new franchise here, according to terms of which a four-mile extension will be made.

Columbia, Mo.—Proposition has been made to local Commercial Club to raise \$5,000 for making preliminary surveys and securing right of way for an electric railway from Mexico, Mo., to this city. Proposed road is 30 miles long and will cost about \$500,000. O. W. Sprotte, President of the General Electric Inspection Co. of St. Louis, and V. M. Disaffrey, Superintendent of the A. J. Deare Co., Buffalo, N. Y., are promoting the enterprise.

Springfield, Mo.—W. S. Cunningham, Chief Engineer Springfield Traction Co., has completed the survey of the proposed extension of the Monroe St. line to the campus of the State Normal grounds.

St. Louis, Mo.—County Court has granted the Fern Ridge & Western R. R. Co. an extension of one year in which to start work on its proposed road in the county. The line is to be on Olive St. road and will run between St. Louis and Creve Coeur Lake.

Omaha, Neb.—Omaha & Council Bluffs Street Ry. will double track its line to the Florence limits.

Lincoln, Neb.—Omaha, Lincoln & South-eastern R. R. has been incorporated with a capital stock of \$100,000, and proposes to build a line between this city and Omaha. The incorporators are E. S. McNaul, New York; C. L. Dundey, Omaha; N. D. Pound, Chicago; L. H. Brumbaugh, New York; L.

G. Ladd, New York; F. H. Rile, New York; G. E. Moffet, New York; S. St. J. Malven, New York, and De Vor Sholes, Omaha.

Rochester, N. Y.—Rochester & Manlius Beach R. R. Co., will start work early in the spring on improving its Manlius Beach line.

Cleveland, O.—Cleveland, Elyria, Coshocton & Zanesville Interurban Co., according to a statement of J. J. Breitinger, Cleveland, its President, has been fully financed and the construction work will be started within two weeks. The road when fully completed will cost \$6,672,000. It is said. The new corporation has taken over the old Cleveland, Brooklyn & Elyria Co. The officers are: J. J. Breitinger, Cleveland, president; W. E. Brooks, Elyria, vice-president; J. H. Kusly, Toledo, secretary, and W. E. Ottman, New York, treasurer.

Mansfield, O.—The Mansfield Railway, Light & Power Co. propose to build tracks on N. Diamond St. from E. Fourth St. to the Central Park this fall.

Youngstown, O.—Lake Erie & Youngstown R. R. Co., John H. Ruhlman, President, will shortly apply for franchise for its terminal in this city. The line is to be built between this city and Conneaut, over a private right of way, and proposes using gasoline motor cars.

Albany, Ore.—A. Welch has been granted electric street railway franchise here.

Portland, Ore.—Portland Railway, Light & Power Co. will expend \$2,000,000 for improvements and extensions.

Middlesex, Pa.—Extension of route of Cumberland Ry. Co., recently granted charter to operate in Middlesex Township, Cumberland County, has been approved. Extension covers 13 miles of streets in Carlisle and townships in that vicinity. W. E. Glatfelter, Balfour, Pa., is President.

Chattanooga, Tenn.—S. W. Divine and J. H. Springfield have petitioned County Court for a franchise to erect overhead trolley wires for the purpose of transmitting power to propel electric automobiles or trackless trolley cars from this city to Coulterville, a distance of 30 miles. It is said that the line will eventually be extended to Dayton.

Ogden, Utah.—Ogden Rapid Transit Co. has asked franchise of County Commissioners for extending its line through Ogden Canyon to Huntsville.

Snohomish, Wash.—Messrs. Dale and Brown of the Snohomish Daily Tribune have asked City Council for a franchise on a number of streets for a street railway.

Sewers.

Items Arranged Alphabetically by States.

Bessemer, Ala.—New bids are to be asked for completing 3rd Ave. storm sewer.

Montgomery, Ala.—Election is to be held Dec. 14 to vote on issuing \$25,000 of bonds for extending sanitary sewers.

Marvell, Ark.—Surveys have been made for the purpose of estimating the cost of constructing sewer system and water plant for this place.

Newport, Ark.—Council has accepted plans and specifications for a sewer system and has appointed a board consisting of N. B. Wishon, W. B. Chastain and John W. Stagton to carry out the work.

Chico, Cal.—Residents of the east side are planning to build by private contract sewer for that section of city. John Waterland and Gus Neubarth are interested.

Monterey, Cal.—Sewer is to be constructed on Cass and Webster Sts.

Hayward, Cal.—Board Trustees have ordered construction of sewers in 3rd St. and Main St.

Roseville, Cal.—Roseville Chamber of Commerce has petitioned County Supervisors to call special election to establish sewer district for this city. Estimated that system can be installed for about \$35,000.

San Francisco, Cal.—Bill has been passed ordering construction of a portion of the East Potrero Intercepting sewer at an estimated cost of \$130,000. Sewers to cost about \$53,000 were also ordered. M. Manson is City Engineer.

Monroe, Ga.—Date for opening bids for constructing sewer system for this city has been postponed from Oct. 7. F. H. Thomas is City Clerk.

Grundy Center, Ia.—City Council has decided not to have work started on the new sewer system until next spring. Iowa Engineering Co., Clinton, Ia., are the engineers.

Mason City, Ia.—Council has adopted resolutions for the construction of a number of branch sewers.

Chicago, Ill.—Ten bids were received Oct. 15 by Board Local Improvements for the construction of the Western Ave. sewer, the bids ranging from \$427,609 to \$588,000. The engineer's estimate was \$597,814. John W. Farley, at \$427,609, was low bidder, and the Federal Improvement Co., 217 La Salle St., was the next lowest.

East St. Louis, Ill.—Final hearing is to be held Oct. 28 on the construction of a sewer to cost \$743,000. The work will include a pumping station and a system of concrete sewers.

Lincoln, Ill.—Board Local Improvements is considering constructing 12-in. sewer in North Hamilton St.

Moline, Ill.—City Council has passed ordinance for construction of sewer and water system for the 6th Ward. Estimated cost is \$45,000. Clark G. Anderson is City Engineer.

Olney, Ill.—Special election is to be held to vote on installing sewer system.

Prophetstown, Ill.—Sewer is to be constructed in Locust St. at a cost of about \$7,000.

Quincy, Ill.—Public hearing was held Oct. 17 by Board Local Improvements regarding construction of North End sanitary sewer system. According to estimate of City Engineer Hancock the system will cost about \$54,000, including 6,083 lin. ft. of 24x36 in. 2-ring, egg-shaped brick sewer at \$4.56 per foot; 949 lin. ft. of 30-in. pipe sewer at \$2.68 per lin. ft.; 4,241 lin. ft. of 24-in. pipe sewer.

Springfield, Ill.—Council has passed ordinance for the construction of a sewer in the south end of the city. Sewer is to be brick, 4 ft. in diameter, and 1,800 ft. long, and will cost about \$7,200.

Indianapolis, Ind.—Board Public Works has confirmed resolution for construction of Brightwood sewer system and bids will be asked at once. Sewer will cost about \$190,000 and will be built of concrete or brick ranging in diameter from 2½ ft. to 10 ft.

Vincennes, Ind.—Ordinance is to come before City Council to appropriate \$1,700 from the general fund for the purpose of securing the services of a civil engineer to prepare plans and specifications for a general system of storm and sanitary sewerage for the entire city.

Independence, Kan.—City Council has adopted plans and specifications for the west side sewer and bids are to be asked at once.

Lexington, Ky.—City will vote Nov. 3 on issuing \$25,000 of bonds for extending main sewer system. J. E. Cassidy is City Clerk.

Lowell, Mass.—Council has appropriated \$20,000 for sewer construction.

Alpena, Mich.—Council has decided to build new brick sewer in Cedar St., the work to commence at once.

Grand Rapids, Mich.—L. W. Anderson, City Engineer, has completed plans and specifications for the pumps which are to be installed in the four sewer pumping stations.

Trenton, Mich.—Mason L. Brown, C. E., Detroit, Mich., has completed plans and specifications for sewer system for this village. Estimated cost is \$45,000. John M. Reid is Village President.

Cartersville, Mo.—City Engineer has made preliminary surveys for building district sewers.

Joplin, Mo.—Council has granted permission to let \$25,000 of work by private contract. The improvements are to be made in the Roanoke addition north of the city. They include the building of sewers, grading of streets and the building of sidewalks.

St. Joseph, Mo.—Board Public Works has decided to expend \$250,000 in building main sewers this winter. According to President Ryan of the Board, the City Council will be asked to authorize employment of additional assistance in the preparation of plans and specifications for the work.

St. Joseph, Mo.—Board of Public Works will call for bids for extending Oak Hill branch of Mitchell Ave. sewer. An issue of \$250,000 of sewer bonds has been voted.

Alliance, Neb.—City is taking steps to install sewer system.

Columbus, Neb.—City voted Oct. 20 on issuing \$4,000 of bonds for a sewer system.

Paterson, N. J.—City has finally decided to join the trunk sewer project of the Passaic Valley Sewerage Commission.

Washington, N. J.—Committee, A. C. Godfrey, Chairman, has recommended that steps be taken to secure a sewer system.

Mount Airy, N. C.—Mount Airy Sewerage Co. has been chartered with capital stock of \$10,000. Rev. R. D. Haymore, Mount Airy, is the principal incorporator.

Binghamton, N. Y.—City has been granted permission to extend Mill St. sewer and build a sewer in South Mozart St. D. C. Herlick is City Engineer.

Newburg, N. Y.—Residents of Greenville have petitioned City Council to construct a 1,400-ft. sewer in that section.

Watertown, N. Y.—Sewers are to be constructed in Meadow, Maple, Pine and West Mullin Sts. at a cost of \$5,500.

Alliance, O.—State Board of Health has decided that this city must erect a new sewage disposal plant. It will cost from \$60,000 to \$75,000.

Ashtabula, O.—L. A. Amsden, City Engineer, has completed plans for the new west end sewer district.

Galion, O.—Following bids were received for constructing intercepting sewer for this city: A. J. Stough, Galion, \$27,887; P. Drake & Sons, Marion, \$22,384; J. Murphy & Co., Marion, \$24,454; United States Construction Co., Columbus, \$23,389; H. J. Clover, Lorain, \$22,026; W. H. Matthews, Lorain, \$23,440; L. P. Batterfield, Bucyrus, \$26,933; Stratton & Applegate, Alliance, \$31,110; Price & Hurley, Marion, \$22,537. The engineer's estimate for the work was \$26,304.

Hartwell (P. O. Cincinnati), O.—Riggs & Sherman, Toledo, O., are engineers for installing new system of sanitary sewers and sewage disposal for this place.

Jefferson, O.—County Commissioners have rejected all bids received Oct. 12, for constructing sewer for court house and county jail building. P. C. Rennick is County Auditor.

Niles, O.—Board Public Service has asked Council to provide funds for a sewage disposal plant.

Enid, Okla.—Special election is to be held to vote on issuance of \$250,000 of bonds for storm water sewer.

Sellwood (P. O. Portland), Ore.—Plans have been made for a sewer system for that part of city west of E. 15th St. to cost \$100,000.

Pottstown, Pa.—Borough is considering installing 15 miles of sewers and a sewage disposal plant. Total cost is \$150,000.

Wilkesbarre, Pa.—Ordinance is before City Council providing for a \$212,000 loan. Of this sum it is proposed to expend \$46,000 for constructing new sewers and \$10,000 for constructing storm sewer from river to Scott St.

Providence, R. I.—Resolution is before Board of Aldermen to lay out Ophelia St., preliminary to the construction of a trunk sewer in Silver Lake District.

Trenton, Tenn.—City Council is considering installing sewer system.

Arlington, Tex.—Mayor Weeks has appointed committee to take steps for installing sewer system for city.

Corpus Christi, Tex.—James Ingram, Taylor, Tex., may ask franchise here for installing sewer system.

Denton, Tex.—City has voted to issue bonds for sewerage purposes. N. Weren-skiold, Dallas, Tex., is Engineer.

Monroe, Wis.—City has decided to build 5,700 ft. long sewer to cost \$4,000.

Toronto, Ont.—Works Committee of City Council has decided on site for erection of proposed sewage disposal plant which is to cost over \$2,000,000.

Water Supply.

Items Arranged Alphabetically by States.

Andalusia, Ala.—Construction of water works and electric light plant for small town near here is proposed. Water will be taken from wells about 200 ft. deep and electric light plant will have 60 to 70 arc lights. Population is 1,800 to 2,500. H. B. Pope, Box 263, Andalusia, is Engineer.

Marvell, Ark.—Surveys have been made for water works and sewers for this place.

Riverside, Cal.—The Empire Water Co. has been incorporated with a capital stock of \$50,000. The directors are: W. W. McCoy, T. B. Ward, v. T. Van Slyke and others.

Estes Park, Colo.—Estes Park Water Co. has been incorporated with capital stock of \$20,000 by J. M. Munson and others.

Dooglas, Ga.—City has voted to issue \$35,000 of bonds, part of which are for light and water plant.

Juliette, Ga.—The city contemplates issuing bonds for constructing water works and electric light plant.

Winterset, Ia.—City has voted to issue \$60,000 of bonds for building new water works.

Hillery, Ill.—Cleveland, Cincinnati, Chicago & St. Louis Ry. proposes to construct reser-

voir and erect pumping plant here. A. E. Tripp, Indianapolis, Ind., is Supervisor Water Service.

Granville, Ill.—Village will vote on issuing \$4,000 of bonds for water works.

Neoga, Ill.—Village is considering installing water works.

Evansville, Ind.—Following bids were received Oct. 12 by Water Works Board for the construction of a filtration plant: Norwood Engineering Co., of Florence, Mass., \$245,000; New York Continental Jewel Filtration Co., of New York, \$262,000; Lightbody Construction Co., Youngstown, O., \$270,000.

Pendleton, Ind.—West Side Water Works Co. has been organized here. J. B. Taylor is President.

Thorntown, Ind.—Village Council has accepted proposition of Gen. Anson Mills for expending \$10,000 or more in putting in a water works system here. A committee composed of C. R. Armstrong, W. C. Burk and R. E. Niven, has been appointed to meet with the town board to look after the matter.

Ely, Minn.—City has decided to install another pump at the light and water plant, and to install another intake to be used in a case of emergency.

Amory, Miss.—Committee consisting of J. A. Mayfield, E. G. Smith and M. P. Redd have been appointed to take steps to install water works.

Stone Harbor, N. J.—The Stone Harbor Water Company has been incorporated with a capital stock of \$50,000 to operate water works in Stone Harbor. The incorporators include: Charles A. Farnum and C. Horace Roberts.

Brockport, N. Y.—Committee consisting of C. P. Lane, M. A. Cleveland and C. T. McFarlane, are considering securing water supply for this place.

Muskogee, Okla.—City has voted to issue \$550,000 in bonds for water and sewer extensions.

Salem, O.—City will vote Nov. 21 on buying local water works plant for \$121,000. John E. Scott is City Engineer.

Newport, Ore.—City is to issue bonds for installing water works.

Quarryville, Pa.—Borough will vote on bonding for \$25,000 for constructing water works.

Presho, S. Dak.—Village has voted to bond for \$6,000 for installing water works.

Yankton, S. Dak.—City will vote on issuing about \$100,000 of bonds for the installing of new water system.

Ennis, Tex.—City has voted to issue \$13,000 of water works bonds.

Goliad, Tex.—Local water works company has been purchased by Joel and Jasper Sharper.

Greenville, Tex.—City has voted an issue of \$76,500 of bonds with which to construct water works.

Sherman, Tex.—City has voted to issue \$30,000 of bonds for public improvements; \$14,000 will be used for the installation of a new water works system.

Farmington, Wash.—Hugh McLeod, Joseph Schnurr and Charles Pears have been appointed a committee by the Mayor to investigate matter of installing water works.

Sunnyside, Wash.—R. E. Cavette has franchise for installing water system and electric plant at this city.

Wilton, Wis.—Village has voted to issue \$10,000 of bonds for establishing water works.

Clarksburg, W. Va.—The West End Water Co. has been incorporated with a capital stock of \$20,000. Incorporators include: O. B. Lawman, F. I. Day and H. Taylor.

Laramie, Wyo.—The James Lake Water Co. has been incorporated with a capital stock of \$25,000. E. T. Tallmadge is interested.

Medicine Hat, Alberta.—City has voted to issue \$15,000 of debentures for water works extensions.

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CONCRETE BRIDGE.

Austin, Texas.

Sealed bids will be received by the Commissioners' Court of Travis County, at Austin, Texas, until 11:30 o'clock A. M., Thursday, November 5th, 1908, for furnishing the necessary labor and materials for constructing a reinforced concrete arch bridge over the Colorado River on Congress Avenue in the City of Austin, and for the removal of the steel bridge now there, all in accordance with plans and specifications on file with the County Judge of Travis County.

Copies of the plans and specifications will be furnished upon application to the County Judge, or to Waddell & Harrington, Consulting Engineers, Kansas City, Mo. A certified check for (\$10,000) ten thousands dollars made payable to Jno. W. Hornsby, County Judge of Travis County, shall accompany each bid, as a guarantee that if the bid is accepted a contract will be entered into and its performance secured.

The bridge will consist of eight spans, each 110 feet long at the springing line and having a roadway 38 feet wide and two sidewalks each five feet wide. The Court reserves the right to reject any and all bids.

By order of the Court.

JNO. W. HORNSBY,

County Judge, Travis County, Texas.
Austin, Texas, Oct. 8th, 1908.

U. S. ENGINEER OFFICE, WILMINGTON, N. C., October 20, 1908. Sealed proposals for constructing a steel draw-span highway bridge with pile and concrete foundations, on Core Creek, near Beaufort, N. C., will be received at this office until 12 noon, standard time, November 20, 1908, and then publicly opened. Information furnished on application. EARL I. BROWN, Captain Engineers.

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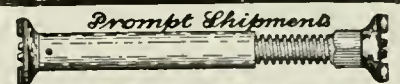
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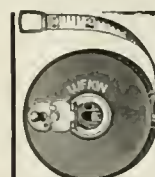
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ROAD WORK.

NOTICE TO CONTRACTORS.

STATE OF NEW YORK, Office of the State Engineer and Surveyor, Albany, N. Y.—Pursuant to the provisions of Chapter 115 of the Laws of 1898, as amended, and 330, Laws of 1908, sealed proposals will be received by the undersigned at his office in the State Hall at Albany, on Monday, the 9th day of November, 1908, at 12 o'clock noon, for the improvement of the following public highways:

Road	No.	Name of Road.	County.	Miles.
309.	Post, Sec. 2.....	Ulster	.....	6.480
321.	Reservation Road			
	- Varick	Seneca	.....	4.310
346.	Sprakers — Rural			
	Grove, Sec. 2., Montgomery ..			2.520
347.	Cana Joharie —			
	Sharon Springs,			
	Sec. 2.....	Montgomery	.....	2.940
392.	Oak Orchard, Sec.			
	1	Orleans	.....	3.342
412.	Port Jervis—Sul-			
	livan Co. Line,			
	Sec. 1.....	Orange	.....	5.740
413.	Highland Mills—			
	Monroe	Orange	.....	3.270
440.	Philadelphia	Jefferson	.....	5.400
444.	Riverside Drive, Broome			1.140
463.	Manheim Center			
	—Sallsbury	Herkimer	.....	5.520
464.	Salisbury Center			
	—Stratford	Herkimer	.....	5.460
480.	Buffalo, Sec. 4....	Monroe	.....	3.020
481.	Despatch—Pitts-			
	ford	Monroe	.....	.990
489.	Tully	Onondaga	.....	4.440
491.	Hilton—Bartletts			
	Corners	Monroe	.....	1.010
493.	Mendon — Pitts-			
	ford	Monroe	.....	6.260
504.	Troy — Speigle-			
	town	Rensselaer	...1.690	
536.	Schodack Center			
	—Nassau	Rensselaer	...5.190	
543.	Johnstown—			
	Broadalbin, Sec.			
	2	Fulton	.....	6.350
547.	Willets — East			
	Williston —			
	Westbury Pond, Nassau			6.430
553.	Fly	Onondaga	...2.330	
554.	Fabius	Onondaga	...4.910	

Sealed proposals will also be received by the undersigned at his office in the State Hall, at Albany, on Wednesday, the 11th day of November, 1908, at 12 o'clock noon, for the improvement of the following highways:

Road	No.	Name of Road.	County.	Miles.
564.	Rome: Augusta—			
	Westmoreland ..	Oneida	.....	5.020
571.	Spring Ave., Troy			
	—Poestenkill	Rensselaer	...2.610	
585.	Towners Corners			
	—County Line, Putnam			3.930
604.	Troy — Schenec-			
	tady, Sec. 3.....	Albany	.....	3.880
610.	Mechanicsville—			
	Malta	Saratoga	7.420	
612.	Pawling — Dover			
	Town Line.....	Dutchess	2.920	
627.	Wicopee — Beek-			
	man	Dutchess	8.100	
630.	Troy and Schen-			
	ectady, Sec. 4....	Albany	.....	2.240
635.	Geneva — Halls			
	Corners	Ontario	.....	5.040
636.	Stanley—Geneva..	Ontario	.....	3.160
642.	Angola — Evans			
	Center; Angola			
	—Brant	Erie	.....	6.900
644.	Alden — Town			
	Line, Sec. 2....	Erie	.....	.730

Sealed proposals will also be received by the undersigned at his office in the State Hall, at Albany, on Wednesday, the 11th day of November, 1908, at 12 o'clock noon, for the improvement of the following highways:

Road	No.	Name of Road.	County.	Miles.
564..	Rome: Augusta—			
	Westmoreland	Oneida	.....	5.020
571..	Spring Ave., Troy			
	—Poestenkill	.....	Rensselaer	2.610
585..	Towners Corners			
	—County Line,	Putnam	.....	3.930
604..	Troy — Schenec-			
	tady, Sec. 3.....	Albany	.....	3.880
610—	Mechanicsville—			
	Malta	.....	Saratoga	7.420
612..	Pawling — Dover			
	Town Line....	Dutchess	.....	2.920
627..	Wicopee — Beek-			
	man	.....	Dutchess	8.100
630—	Troy and Schen-			
	ectady, Sec. 4.....	Albany	.....	2.240
635..	Geneva — Halls			
	Corners	.....	Ontario	5.040
636..	Stanly—Geneva.....	Ontario	.....	3.160
642..	Angola — Evans			
	Center; Angola			
	—Brant	.....	Erie	6.900
644..	Alden — Town			
	Line, Sec. 2.....	Erie	.....	.730

645..Orchard Park —				
Grillins Mills.....	Erie	.....	4.640	
646..Indian Fields —				
Bormansville	Albany	.....	4.120	
650..Hudson Hollow-				
ville	Columbia	.....	5.660	
652..Champlain — Per-				
rys Mills.....	Clinton	.....	3.250	
654..Oswego — Mexi-				
co, Sec. 2.....	Oswego	.....	5.350	
663..Otselic — South				
Otselic, Sec. 2.....	Chenango	.....	4.420	
681..Ithaca — Dry-				
den, Sec. 1.....	Tompkins	.....	5.230	
685..Stirling — Oswe-				
go	Cayuga	.....	4.880	
690..Monsey — Egypt				
Corners	Rockland	.....	4.250	

Sealed proposals will also be received by the undersigned at his office in the State Hall, at Albany, on Friday, the 13th day of November, 1908, at 12 o'clock noon, for the improvement of the following highways:

Road	No.	Name of Road.	County.	Miles.
708..Sidney — Una-				
dilla	Otsego	.....	4.680	
713..North Tonawan-				
da—Shawnee	Niagara	.....	5.130	
714..Dansville — Mt.				
Morris, Sec. 1.....	Livingston	.....	5.370	
723..Whitehall — Fort				
Ann Town Line, Washington ..	4.770			
725..Grand Central				
Avenue, Sec. 2.....	Chemung	.....	.900	
727..Chittenango —				
Oneida, Sec. 1.....	Madison	.....	5.150	
734..Potsdam — Par-				
ishville, Sec. 1.....	St. Lawrence	.....	5.120	
736..North Creek —				
County Line.....	Warren	.....	4.120	
737..Cortland — Trux-				
ton—Cuyler	Cortland	.....	5.790	
747..Delhi — Bloom-				
ville	Delaware	.....	5.910	
750..Clarence Center.....	Erie	.....	5.950	
754..Bath — Savona.....	Steuben	.....	1.460	
768..Ossining — Kit-				
chewan	Westchester	.....	5.860	
769..Amawalk—Woods				
Bridge	Westchester	.....	4.210	
770..Golden Bridge—				
Turk Hill.....	Westchester	.....	3.850	
784..Cooperstown —				
Three Mile				
Point	Otsego	.....	3.120	
788..South Schenec-				
tady — Maria-				
ville	Schenectady	.....	7.320	
794..Huntington —				
Amityville	Suffolk	.....	10.140	
795..Jeffersonville —				
Kenoza Lake—				
Fosterdale	Sullivan	.....	6.200	
796..Greenville — Cox-				
sackie, Sec. 1.....	Greene	.....	4.620	

Plans and specifications may be seen and proposal forms obtained at the office of the division engineer of the Eastern Division in the State Hall, at Albany, N. Y., for roads in the counties of Albany, Clinton, Columbia, Delaware, Dutchess, Fulton, Greene, Herkimer, Montgomery, Nassau, Orange, Otsego, Putnam, Rensselaer, Rockland, Saratoga, Schenectady, Suffolk, Sullivan, Ulster, Warren, Washington and Westchester; at the office of the division engineer of the Middle Division in the Welghlock Building, Syracuse, N. Y., for roads in the counties of Broome, Cayuga, Chenango, Cortland, Jefferson, Madison, Oneida, Onondaga, Oswego, St. Lawrence, Seneca and Tompkins; and at the office of the division engineer of the Western Division in the Triangle Building at Rochester, N. Y., for roads in the counties of Che-

mung, Erie, Livingston, Monroe, Ontario, Niagara, Orleans and Steuben.

The attention of bidders is especially called to Paragraph 7 of "Information for proposers" on page 2 of the specifications. Proposals for each road must be presented in a separate, sealed envelope endorsed on the outside with the name and number of the road for which the proposal is made.

Each proposal must be accompanied by a New York draft or a certified check payable at sight to the order of the State Engineer and Surveyor for an amount equal to at least five per cent of the amount of the proposal which such draft or check will be held by the State Engineer until the contract and bond are duly executed. The successful bidder will be required to give a bond for fifty per cent of the contract price, such bond to be executed by a surety company to be approved by the State Engineer and Surveyor.

The right is reserved to reject any or all bids.

FREDERICK SKENE,
State Engineer and Surveyor.

BOILERS, STEAM ENGINES AND CENTRIFUGAL PUMPS.

Pekin, Ill., Oct. 26, 1908.

Sealed bids will be received by the Commissioners of the Spring Lake Drainage and Levee District, at the office of W. A. Potts, Attorney, Pekin, Illinois, until ten o'clock a. m., Tuesday, November 24th, A. D. 1908, for two 250 H.P. water tube boilers, two 350 H.P. compound condensing steam engines direct connected to two 45-inch or 48-inch centrifugal pumps with 48-inch discharge pipes, and one 100 H.P. compound condensing steam engine, direct connected to one 24-inch centrifugal pump with 26-inch discharge pipe, together with all appurtenances and fixtures complete on foundation to be furnished by the purchasers in their pumping plant at the lower end of the Spring Lake Drainage and Levee District on the east bank of the Illinois river about seventeen miles south of Pekin, Illinois.

Bids must be accompanied by certified check of five (5) per cent of the amount of the bid.

Plans and specifications and full information will be furnished upon application to the Engineers.

HARMAN ENGINEERING CO.,
Engineers.

120 Fredonia Ave., Peoria, Ill.

PROPOSALS FOR THREE RAPID UNloading cranes. Sealed proposals will be received at the office of the General Purchasing Officers, Isthmian Canal Commission, Washington, D. C., until 10:30 a. m., November 16, 1908, which time they will be opened in public, for furnishing the above-mentioned articles. Blanks and general information relating to this Circular (No. 475) may be obtained from this office or the offices of the Assistant Purchasing Agents, 24 State street, New York City; Custom-House, New Orleans, La.; and 1086 North Point street, San Francisco, Cal.; also from the U. S. Engineer Offices in the following cities: Seattle, Wash.; Los Angeles, Cal.; Baltimore, Md.; Philadelphia, Pa.; Pittsburgh, Pa.; Boston, Mass.; Buffalo, N. Y.; Cleveland, Ohio; Cincinnati, Ohio; Chicago, Ill.; St. Louis, Mo.; Detroit, Mich.; Milwaukee, Wis.; St. Paul, Minn.; Chattanooga, Tenn.; Louisville, Ky.; Mobile, Ala.; and Galveston, Tex.; Commercial Club, Kansas City, Mo.; Chamber of Commerce, Quincy, Ill.; and Chamber of Commerce and Board of Trade, Tacoma, Wash.—F. C. Boggs, Captain Corps of Engineers, U. S. A. General Purchasing Officer.

Edson Diaphragm Trench Pumps

OUR EDSON IMPROVED PUMPS

can be operated by the most ignorant workman, and they will handle Sand, Mud, Gravel, Sanitary Deposits and anything limpid enough to flow without clogging or injury.

Complete Outfits, including Pump, Edson Special Suction Hose, Extra heavy Brass Couplings, Strainer and Spanner **ready for business.** Extra lengths of **Suction Hose**, guaranteed **Diaphragms** and duplicate Pump parts, **carried in stock.**

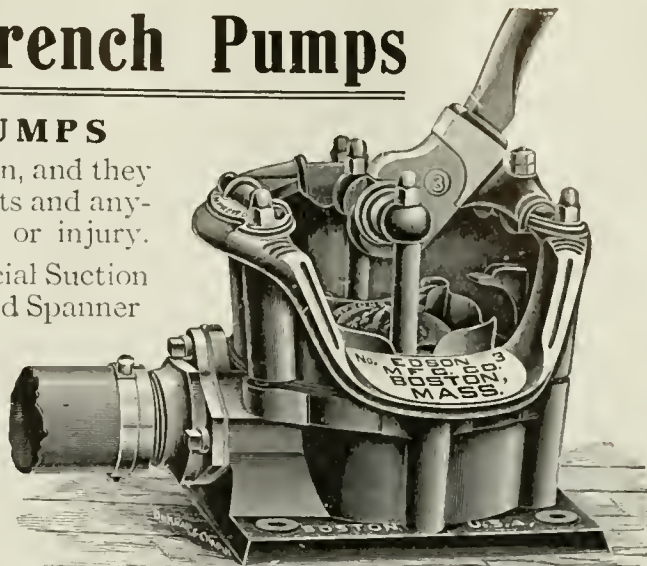
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Boston, Mass.



GENERAL WORK, CITY HALL, DEPARTMENT OF PUBLIC WORKS

Chicago, Oct. 1, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m. Monday November 2, 1908, at room 705, No. 200 Randolph street, for the general work required in connection with the construction of the new city hall building to be erected on the west half of block 39 original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, architects, 16th floor, Monadnock block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, General Work," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the commissioner of public works, which deposit will be returned to the bidder if the bid is rejected, and if the bidder is successful, upon bidder entering into contract with said city of Chicago and giving such bond as may be required for the satisfactory performance of the same within five days from the date of notification that the said contract and bond are ready for execution.

The commissioner of public works reserves the right to reject any or all bids. A deposit of \$500 will be made in room 705, No. 200 Randolph street, to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.
By PAUL REDIESKE,
Deputy Commissioner.

WATER-WORKS.

Shawnee, Ohio.

Sealed proposals will be received at noon on Nov. 5, 1908, at the Council Chamber, Shawnee, O., for furnishing and laying about 9,433 feet of 4, 6 and 8 inch cast iron water pipe with valves, hydrants, etc. Plans and specifications on file with Village Clerk and at office of Bradbury & Shute, Engineers, Hayden bldg., Columbus, Ohio. A certified check or bond for \$250 must accompany each bid. A bond for 50 per cent of the amount of the contract will be required on execution of the contract. The right to reject any or all bids is reserved.

JOHN D. DAVIS,
Secretary.

FILTRATION PLANT.

Wilmington, Del.

Sealed proposals will be received by the Board of Water Commissioners at the office of the Water Department, southeast corner Sixth and King Streets, Wilmington, Delaware, until 10:30 a. m. on Monday, Nov. 23, 1908, for the construction of a covered, slow sand filtration plant, together with filtered water reservoir, filter sand washing apparatus and other appurtenances; the kind and the amount of work to be done or furnished under said proposals to be according to plans and specifications which may be seen in detail at the office of the Chief Engineer of the Water Department, southeast corner Sixth and King Streets, Wilmington, Delaware, to which reference is hereby made.

The contract for the doing of the work and the furnishing of all materials and supplies covered by such plans and specifications will be awarded to the lowest and best bidder, provided that the Board of Water Commissioners reserves the right to reject any or all bids.

Each bid must be signed by the bidder and be accompanied by an undertaking signed by the persons offered by the bidder as his sureties, who must, in all cases, be resident freeholders of the City of Wilmington, or a thorough responsible surety company, which company or companies must be acceptable to the Board of Water Commissioners, declaring their consent to be such sureties in the event

of the contract being awarded to such bidder; and if any contract be so awarded, and such bidder shall fail to complete the execution of a contract therefor, with security for its performance approved by the said Board, such bidder and the party or parties, company or companies, so undertaking for him, as aforesaid, shall be liable to pay to the City of Wilmington any damage that may be occasioned to said city by such failure; bond required in the sum of 25% of the contract price.

Form of proposals and contracts may be obtained at the said office of the Chief Engineer of the Water Department.

Copies of the specifications and plans may be secured upon making a deposit of twenty-five dollars, said deposit to be returned upon the return of the plans and specifications.

By order of Board of Water Commissioners.

JOHN A. KIENLE, Chief Engineer.
Attest: CHAS. MCINTIRE, Secretary.

SEWER SYSTEM.

Selma, California.

Sealed proposals for the construction of a sanitary sewer system of vitrified salt glazed sewer pipe for the Town of Selma, California, will be received at the office of the Board of Trustees of said Town until 7:30 o'clock, P. M., of Nov. 2d, 1908.

The work will consist of the following principal approximate quantities: Furnishing, trenching, laying and backfilling, 35,345 lineal feet 6-inch sewer, 10,576 lineal feet 8-inch sewer, 5,179 lineal feet 10-inch sewer, 576 lineal feet 12-inch sewer inside city limits.

Together with 20,474 lineal feet of 12-inch outfall sewer.

One sewage tank of 19,800 cubic feet capacity, all according to plans and specifications on file with the City Engineer, Selma, Cal., where the same may be seen or copies will be forwarded to intending bidders on receipt of \$5.00 certified check or currency deposited as a guarantee for the return of the plans.

Each bid must be accompanied by a certified check in the sum of \$2,000.00 payable to the Town of Selma, California.
R. C. GIBBS, City Clerk.

NOTICE TO DREDGING AND TILE DRAIN CONTRACTORS.

Burlington, Iowa, Oct. 20, 1908.

Sealed bids will be received by the Joint Board of Supervisors of Louisa County and Des Moines County, State of Iowa, acting for and on behalf of the Louisa-Des Moines Drainage District Number 4 of said counties, at the office of the Auditor of Des Moines County, Burlington, Iowa, until two o'clock p. m., November 14, A. D. 1908, at which time and place said bids will be publicly opened. The work for which bids are asked is a part of the drainage system of said Drainage District as follows, viz.:

Section 1. Excavation, 200,000 cu. yds.
Section 2. Excavation, 17,460 cu. yds.
Section 3. 18-in. tile drain, 8,200 lin. ft.
15-in. tile drain, 2,400 lin. ft.
as described in detail in the specifications thereon on file with the Auditor of each of said counties.

Each bid must be accompanied by cash or certified check equal to ten per cent of the amount of the bid.

Plans and specifications are on file and may be seen at the office of the County Auditor of Louisa County, Wapello, Iowa, at the office of the County Auditor of Des Moines County, Burlington, Iowa, and at the office of the Harman Engineering Co., Engineers, 120 Fredonia Ave., Peoria, Illinois. Copy of specifications, Form of Contract and Form of Bid may be procured by application to the Engineers.

Joint Board,
D. H. V. HERRICK,
O. C. FARMER,
R. S. JOHNSTON,
Supervisors of Louisa County.
A. SCHWALLER,
R. D. SIEFKEN,
JOHN H. PETTIBONE,
Supervisors of Des Moines County.

DAN P. HILL, County Auditor, Des Moines County.

H. W. BAKER, County Auditor, Louisa County.

HARMAN ENGINEERING CO.,
Engineers,
120 Fredonia Ave., Peoria, Ill.

CONCRETE BRIDGE.

Charles City, Iowa.

The Board of Supervisors of Floyd County, Iowa, will receive, at the office of the county auditor in Charles City, Iowa, until 10 a. m., November 12, 1908, sealed bids and proposals with plans accompanying same, for the building and construction of a steel concrete bridge, approximately 262 feet long and 73 feet wide across the Cedar river, on Main street in Charles City, Iowa, during the year 1909.

A certified check in the sum of \$1,000 payable to J. G. Cutler, chairman of the board of supervisors of Floyd County, Iowa, must accompany each bid and proposal, said sum to be forfeited to Floyd County upon failure of successful bidder to enter into and sign contract and give bond within 30 days from award of contract.

The board reserves the right to reject any or all bids, proposals, plans and specifications.

Dated at Charles City, Iowa, October 10th, 1908.

J. W. CUTLER, Chairman,
Board of Supervisors.

Attest: H. B. ROSENKRANS,
County Auditor.

SEWERAGE SYSTEM FOR THE VILLAGE OF HAVER-STRAW, N. Y.

Sealed proposals for building a sewer system for the Village of Haverstraw, N. Y., in accordance with the contract and specifications to be furnished by the Board of Trustees, will be received at the Village Hall at 7:30 p. m., on November 4, 1908, and at that time and place will be publicly opened and read.

The work includes the following approximate quantities:

Screening chamber complete.
2,470 ft. of 36-inch brick or combination concrete and brick sewer.
1,170 ft. of 30-inch brick or combination concrete and brick sewer.
974 ft. of 18-inch double strength vitrified pipe sewer.
2,332 ft. of 15-inch double strength vitrified pipe sewer.
1,832 ft. of 12-inch double strength vitrified pipe sewer.
4,890 ft. of 10-inch double strength vitrified pipe sewer.
37,375 ft. of 8-inch double strength vitrified pipe sewer.
240 ft. of 30-inch cast-iron pipe sewer.
120 ft. of 16-inch cast-iron pipe sewer.
36 ft. of 10-inch cast-iron pipe sewer.
84 ft. of 8-inch cast-iron pipe sewer.
119 manholes.
47 flush tanks.
1,200 ft. of submerged 14-inch cast-iron pipe.

Proposals must be accompanied by a certified check for \$5,000.

Plans and specifications can be seen at the office of the Village Clerk, and at the office of Alexander Potter, Consulting Engineer, 143 Liberty street, New York City.

The right is reserved to reject any or all bids.

By order of the Board of Trustees,
THOMAS LYNCH, President.
HENRY F. DORL, Clerk.
ALEXANDER POTTER, Chief Engr.

DRAINAGE DITCH.

Northwood, Iowa.

Sealed bids will be received by the County Auditor of Worth County, Iowa, up to 1 o'clock p. m., Nov. 11, 1908, for the construction of a drainage ditch and tile drains in Worth County, consisting of open ditch estimated at 74,110 cu. yds., and 27,941 lin. ft. of 6, 8, 10, 12 and 15-in. tile. Work on open ditch to be completed by December 1, 1909, and the tile drains to be completed by Dec. 1, 1910.

IVER IVERSON, JR., County Auditor.

GRADING RESERVOIR.

Greenville, Texas.

The city of Greenville will receive bids for the grading of an earth embankment reservoir, containing about ninety thousand (90,000) cubic yards, near Greenville, Tex., until 12 o'clock noon on the 3d day of November, A. D. 1908. Copies of plans and specifications and proposal sheets can be seen at the City Secretary's office at Greenville, Texas, or at the office of John W. Maxey, Houston, Tex. Each bid must be accompanied by a certified check in the sum of five hundred dollars (\$500) and the contractor must be prepared to give bond in the sum of five thousand dollars (\$5,000). The city of Greenville reserves the right to reject any and all bids.

JOS. F. NICHOLS, Mayor.
MAXEY & HORTON, Engrs. in Charge.

FOR SALE OR RENT

Two Vulcan shovels, 1½ yard and 2½ yard, 3 sets engines.
Two 42" gauge saddle tank 9 x 14, locomotives, saddle tank.
Two 36" gauge locomotives, saddle tank, 9 x 14.
30 and 56 lb. relayers with plates.

Traction engines, hoisting engines, pumps, etc.

HARPER MACHINERY COMPANY
1861 Fulton Bldg., Hudson Terminals,
50 Church Street, New York
Yards and Shops, Bloomfield N. J.

For Sale at Once

the following list of machinery and apparatus in good working order, located at

Lincoln Park, Chicago.

1 tandem compound Buckeye engine, size 11x19x16, speed 250 r.

1 simple Ideal engine, size 13x14, speed 250 r.

2 No. 7 type I. C. F. 6.8-ampere Western Electric D. C. arc dynamos, capacity 100 inclosed arc lamps, speed 650 r.

The following list will be available on or before Jan. 1, 1909:

1 Frazer & Chalmers cross compound Corliss engine, size 17x25x30 in., direct connected to two Riedler pumps, size 12¼x30 in., capacity 8,000,000 gallons in 24 hours, speed 100 revolutions.

1 tandem compound Buckeye engine, size 11x19x16, speed 250 r.

1 Ideal tandem compound engine, size 11x18x14, speed 250 r., direct connected to 100 k. w. G. E. A. C. generator, 2-phase, 60-cycle, 2,300-volt, primary, 110-volt, secondary, speed 250 r., exciter attached.

1 Worthington jet condenser, size 12x14x10 in.

1 tandem compound Dean pump, size 12x18x12x18.

1 boiler feed pump, size 6x4x6.

1 boiler feed pump, size 7½x5x6.

1 simple New York safety engine, size 14x14, speed 250 r.

1 vertical air compressor, size 8½x8½x9.

2 Heine safety boilers, 290 horsepower each, size 48x21x9¼ in.

2 No. 7 type I. C. F. 6.8 ampere Western Electric D. C. arc dynamos, capacity 100 inclosed arc lamps, speed 650 r.

2 type F 6.8 ampere Western Electric D. C. arc dynamos, capacity 60 inclosed arc lamps, speed 1,000 r.

1 45 k. w. 2 phase Westinghouse A. C. dynamo, 60-cycle, 2,300 and 110 volt, with exciter.

1 3-panel marble switchboard, complete with plugs and instruments, size 10x7 ft.

1 1,000-horsepower Stillwell open heater.

96 type 112 D. C. Western Electric inclosed arc lamps, 6.8 ampere.

235 and 414 D. C. Western Electric inclosed arc lamps, 6.8 ampere.

M. H. WEST, Sec. and Supt.,
Lincoln Park Commission, Chicago.

ADDRESSOGRAPH

with 6,000 stencils, cabinets, etc.
complete. Nearly new.

VERY CHEAP.

"Box 12" care of Engineering-Contracting

FOR SALE CHEAP

Second Hand EXCAVATOR, Kearns' Pattern, formerly used by U. S. Government

Also

Two 12-ton 36" gauge and

One 15-ton 36" gauge Saddle Tank Locomotives

Also

Relaying Rails all weights.

BLOCK-POLLAK IRON CO., First National Bank Building, CHICAGO, ILL.

PROPOSALS WILL BE RECEIVED AT the Bureau of Navigation, Navy Department, Washington, D. C., until 12 o'clock noon, November 4, 1908, and there publicly opened immediately thereafter, for the construction of six buildings consisting of a commandant's house, four officers' houses, and a receiving guard-house, at the Naval Training Station, Great Lakes, North Chicago, Illinois. Blank forms of proposals and specifications will be furnished and plans may be procured upon application to the Commandant Naval Training Station, Great Lakes, North Chicago, Illinois.

J. E. PILLSBURY,
Chief of Bureau.

FORT MYER, VA., OCTOBER 20, 1908. Sealed proposals in triplicate will be received at the office of the Constructing Quartermaster, until 11 a. m., November 18, 1908, and then opened, for the construction of fences for corrals for artillery stables at Fort Myer, Va. Certified check or Surety Company's guarantee for 10 per cent of the amount must accompany each bid. Plans and specifications will be furnished upon application. The Government reserves the right to reject any or all bids. Proposals and envelopes should be marked "Proposals for construction of corral fences," and addressed to Captain B. B. HYER, Constructing Quartermaster.

SEWAGE DISPOSAL AND SANITARY SEWERS.

Wyoming, Hamilton County, Ohio.

Sealed proposals will be received by the undersigned at the office of the Village Clerk of Wyoming, Hamilton County, Ohio, until twelve (12) o'clock noon of Wednesday, November 4, 1908, then and there to be publicly opened and read, for the construction of a sewage disposal plant, and about 22,569 feet of sanitary sewers, with the necessary appurtenances.

Size of sewers ranges from eight (8) inches to eighteen (18) inches in diameter, all to be of double strength vitrified pipe.

All proposals to be made on blanks furnished by the village.

Each bidder will accompany his bid with a deposit of ten (10) per cent of the amount of the bid, or certified check for like amount, payable to the order of the undersigned, as a guarantee that within ten (10) days after the acceptance of his bid he will enter into a contract with the village and execute a surety company bond for an amount equal to forty (40) per cent thereof.

Bidders are requested to personally look over the work before bidding.

Plans and specifications can be seen and bidding blanks obtained at the office of the undersigned, or from the Riggs & Sherman Co., Engineers, Toledo, Ohio.

The Village Council reserves the right to reject any or all bids.

By order of Council of the Village of Wyoming, Ohio.

W. A. CLARK,
Village Clerk.

Good Stuff At Right Prices

One No. 2½ Smith Concrete Mixer, complete with engine and boiler, on wheels	\$625
One No. 2 Buffalo Mixer with gasoline engine	\$500
One No. 1 McKelvey Mixer, engine and boiler, on wheels	\$325
One 20 H. P. Lidgerwood Hoist, D. C. D. D. with boiler	\$650
One 80 H. P. Single Drum Hoist, link motion, no boiler	\$900
One No. 2 Austin Gyratory Crusher (new)	\$400
One Lot of Paint Machinery. Very cheap.	
One 45 Ton Bucyrus Steam Shovel, 1½ yard	\$2,200

We have lots of bargains, new and rebuilt. We are dealers, rebuilders and warehousemen of heavy machinery. Let us know what you want.

Shop, Warehouse and Yards,
Harvey, Ill.

H. O. Conklin Equipment Co.
Great Northern Bldg., Chicago.

MARSH'S CRUSHER LIST

- One No. 7 1-2 Style "D" Gates, complete plant with power.
- One No. 7 1-2 Austin Plant, very complete.
- One No. 5 Style "D" Gates Crusher, first-class condition.
- One No. 6 Style "K" Gates Crusher, with No. 4 Style "D" to follow with complete equipment of elevators, screens, power plant, etc.
- One No. 4 Austin Crusher, with elevator and screen and power plant.
- Two No. 3 Style "D" Gates Crushers, good as new, and many others. Write for full particulars, if interested.

P. S.—Also Steam Rollers, Shovels, etc. WRITE FOR LIST.

G. C. Marsh Room 970 Old Colony Bldg., Chicago, Ill.

MARSH'S MIXER LIST

Good Second Hand Concrete Mixers

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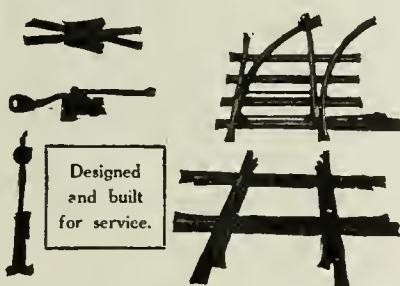
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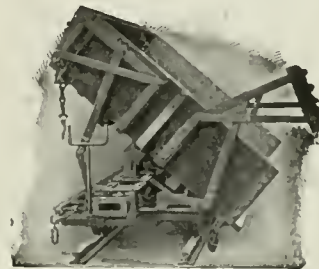
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Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

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An Economic Method of Spreading Broken Stone for Macadam, and Comments Upon Macadam Specifications.

In our issue of Oct. 28 we printed an interesting article on macadam road specifications, taken from a paper by Mr. A. N. Johnson. While we agree, in the main,

with Mr. Johnson's conclusions, there are one or two points that are worthy of further elaboration.

Mr. Johnson prohibits the dumping of broken stone in piles upon the road, and gives his reasons for his restricting the contractor to certain methods of delivering and spreading the stone. We believe that if broken stone is dumped in piles on the subgrade and then scattered or spread by hand, an even distribution of the stone is seldom secured. Where a wagon load of stone is dumped it is evident that the mass of stone at the bottom of the pile is more consolidated than where the same stone has been delivered with shovels. Hence, if we have a stretch of macadam, certain spots of which have been spread by shovels while other parts of which have been left untouched, and therefore consolidated by the fall of the mass from the wagon, we will get undulations in the resulting road surface where the roller begins its work. In other words, there will be, say, 6 ins. of loose stone where the wagon load was dumped and 6 ins. of very loose stone all around, where it has been spread by shovels or rakes, and this condition will yield a macadam road of irregular thickness after rolling.

It is this objection, as well as those others which Mr. Johnson cites, which has led many engineers to prohibit the dumping of stone directly upon the subgrade unless it is dumped from a spreading wagon.

Some ten years ago the managing editor of this journal was engaged, as a contractor, in building a macadam road under specifications that prescribed the spreading of stone from a dumping board or from piles alongside the road. It cost 10 cents per cu. yd. of loose stone to spread it in this manner, wages being 15 cts. an hour. In order to reduce this expense, the writer decided to experiment with some sort of a machine, and selected a Shuart grader (made by the Ohio Machinery Co. of Oberlin Ohio), which has a steel blade, about 5½ ft. long, mounted on a low frame supported by two small wheels and a castor wheel in front. The grader was pulled by two horses, and required one man beside the driver. With this simple little machine it was possible to spread 50 cu. yds. of loose stone in an hour, at a cost of 1 ct. per cu. yd. However, the spreading was by no means as uniform as could be attained by hand, hence it became necessary to supplement the work of the grader by using some sort of hand rakes. For this purpose the writer selected potato hooks. It was found that another 1 ct. per cu. yd was spent in the final hand spreading with the potato hooks, making a total of 2 cts. per cu. yd., as compared with the 10 ct. cost of spreading from dump boards.

To loosen the masses of broken stone where they had been dumped from the wagons, the writer used an attachment that is furnished with the Shuart grader for scarifying or harrowing tough soils, called

a digger. It is nothing but a bar provided with sharp teeth, like a harrow, which is fastened in front of the scraping blade, and can be attached or removed at will.

This device overcame the objections to lumping stone on the subgrade, and saved many hundreds of dollars.

In his paper Mr. Johnson recognized that specifications should be so drawn as to secure desired results rather than to prescribe methods, but holds that it is often simpler to attain desired results by prescribing certain permissible methods. This is sound reasoning, and the corollary from it is that some general clause should exist in all specifications under which the engineer may permit a modification of any method prescribed, provided that an equally good result is obtained. This does not mean that an engineer should be permitted to change the specified thickness of the macadam, for example, without a corresponding change in the contractors' compensation; but it means that the engineer should be free to accept any innovation in methods which a contractor may devise, for thus the contractor's ingenuity is stimulated, not only to the benefit of himself but to the ultimate benefit of the public.

We have mentioned the Shuart grader as having been used successfully for spreading stone. The 20th Century Grader, made by The Baker Mfg. Co. of Chicago, is a similar machine that has likewise proved to be an effective tool for this purpose.

The Western Society of Engineers.

The Western Society of Engineers held last week a reunion of its members that those present will recall with pleasure in the years to come. This meeting was scheduled as a "smoker," merely an informal social gathering of members to renew old friendships and to make new acquaintances. It was all this, but this was not all. Had it been all, the meeting would merely have been one of many. Instead it turned out to be one of a few in spirit and temper. Those who recall the annual meeting and banquet of the society on Jan. 7, 1902, with its address by Mr. Octave Chanute and its after dinner talks by Mr. L. P. Moorehouse, General Sooy Smith, Mr. Isham Randolph and others, need no explanation of this spirit. Most of the same men were present on this last occasion and they spoke again in memory of the society's past and in prophecy for its future. That they spoke well need hardly be said. That they spoke so well, it is well to remember also, was because the subject and the occasion inspired both thought and utterance.

The society's new rooms, the largest and finest quarters that its members have ever had, furnished alone an occasion for jubilation. It was not merely this size and comfort of their new home, however, that signified to those older members present, so much as the strong growth and sturdy

strength of the organization of which the new home was the concrete evidence. It was pride in the society's thousand members, its strong journal, its excellent library and reading room, and its sound financial condition that touched the speakers' tongues with enthusiasm. Truly the society had a right to be proud.

The Civil Engineers' Club of the Northwest was organized on May 25, 1869, with twelve members. In 1880 the name was changed to the Western Society of Engineers. Last week there were present five of the original members of 1869. They are nearly but not quite all that are left of those first year's members. Engineering then was not the well filled profession that it is to-day. Engineering works were not the costly works that they are to-day. The growth of the society was slow. In 1874 there were 71 members and in 1880, when the club became the society, there were only 139 members. A year after its incorporation the society joined with a number of other local engineering societies to publish the "Journal of the Association of Engineering Societies." Previously the papers and discussions had been by arrangement printed in one of the three engineering journals then published, and reprints furnished the members. There were produced in succession five thin volumes of these reprints, one each year from 1876 to 1880, inclusive.

While up to this time the growth of the society had been slow it had also been steady and healthy. But it now almost ceased. In 1884 the membership was 135, and the income was only about two-thirds of the expenditures. The next year presented an even worse showing, there were only 106 members in good standing. The depression continued until 1889; then the society took a new lease of life and grew rapidly. In 1891 it was voted to withdraw from the Association of Engineering Societies and to publish an independent journal. The change proved successful from the start and the "Journal of the Western Society of Engineers" is one of whose size and quality any organization would have reason to be proud.

To-day the Western Society of Engineers is a strong, growing organization of engineers. It is gaining new members. Its library, reading rooms and meeting hall are large and well arranged; it has a yearly balance over expenditures and a snug sum invested. Its meetings are well attended and its papers and discussions are of a high character. We mention these things here not because they are unknown or unique, but because of their promise of service to young engineers. Everyone of these young engineers who is not already a member, and there are many of them in Chicago, can take no more profitable step than to affiliate himself with the society in one of its several grades of membership.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Methods of Waterproofing Concrete Covered Steel Floors for Railway Bridges with Some Figures on Cost.

The following methods of waterproofing concrete covered steel floors for bridges are given in a committee report presented at the recent convention of the Association

of American Railway Superintendents of Bridges and Buildings:

I beams. We are now using on some of our through and deck plate girder bridges, reinforced concrete floors.

In the girder spans the waterproofing is carried up the side of the girder a short distance above track level and in some cases a water guard is used, as in the well known Hydrex system, while in some cases the water guard is omitted and the adhe-

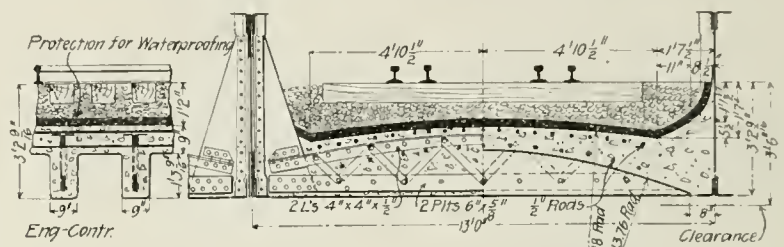


Fig. 1—Waterproofing Concrete Bridge Floor, N. Y., N. H. & H. R. R.

of American Railway Superintendents of Bridges and Buildings:

New York, New Haven & Hartford Ry. (W. H. Moore).—Figures 1, 2 and 3 show the methods which have been employed within the last year for waterproofing solid floor bridges on the Harlem River branch, but this work has not been in service long enough for us to form an opinion as to the efficiency of the systems used. The general specifications for the work are as follows:

"After surface of concrete has been cleaned, apply a coat of Sarco concrete paint. Over this mop a thin coat of hot Sarco No. 6 Waterproofing. On this second coat lay a mastic coat 1 3/4 ins. thick, in proportion of 1 part Sarco Waterproofing to 4 parts of sand, or sand and pebbles. Iron to a smooth finish. Over this put a finishing coat of hot Sarco Waterproofing, spread thinly and evenly, and sprinkle with torpedo sand. Protect expansion joints by a fold of burlap saturated with Sarco No. 6 waterproofing. Carry the water back of the abutments by a curtain of burlap saturated with Sarco No. 6 Waterproofing."

I think it has come to be very generally recognized that in order to be effective the waterproofing material must have a good smooth surface to rest on without any sharp corners or angles and that the waterproofing layer must in its turn be covered by a protective coating which will prevent it from injury when the track is being tamped or otherwise, and also protect it from the direct action of the sun.

In our solid floor construction, we have hitherto principally used the trough system of floor, but in certain instances have used

sion of the waterproofing to the web of the girder depended on to maintain a tight joint.

In trough floor bridges of three or more spans where the expansion has to be taken care of in the troughing, we have put in special construction with copper flashing to make allowance for the expansion. This

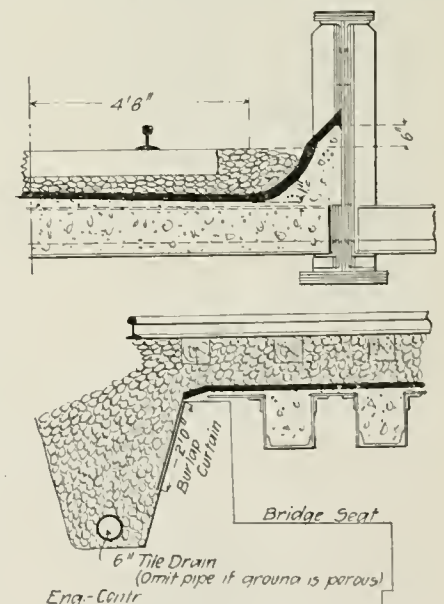


Fig. 2—Waterproofing Concrete Bridge Floor, N. Y., N. H. & H. R. R.

construction, however, has not been in service long enough for us to know whether it will be entirely satisfactory or not.

The waterproofing is protected from the stone ballast either by a layer of brick

work or by a layer of mastic, $1\frac{3}{4}$ to 2 ins. thick.

*Pennsylvania R. R. (C. W. Richey).—*We use both I beam and trough section in our solid floor construction, with a preference, however, for the trough floor. Our present standard calls for trough section

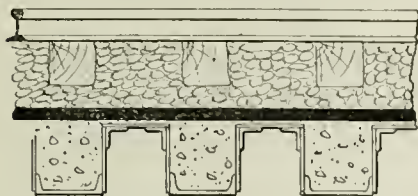


Fig. 3—Waterproofing Concrete Bridge Floor, N. Y., N. H. & H. R. R.

parallel to the rail for spans up to and including 30 ft. With this arrangement we have a fascia girder on each side of the bridge to hold the ballast.

Where solid floor is desired for spans longer than 30 ft. we use girders and run the trough section normally to the girders, connection being made directly to the web of the girders. With this arrangement our waterproofing is run above the ballast line, the steel work remaining unpainted until waterproofing is applied, in order to provide proper adhesion.

We experience considerable difficulty with all forms of waterproofing used, excepting a waterproofing built up of felt paper.

We have used asphalt, pitch and other preparations, usually 1 to $1\frac{1}{2}$ ins. in thickness, on the top of a properly troweled cement bed. This method of waterproofing to my mind is unsatisfactory, as it cracks in time, permitting leaks.

Our standard at present consists of five alternate layers of Hydrex felt and Hydrex compound, all being placed on the top of

asphalt or pitch composition. Expansion or contraction of either the steel or concrete work has no effect on this style of waterproofing.

At our Union Station, Pittsburg, the driveways and Adams express department are under a trough floor system which was originally waterproofed with a 2-in. thickness of asphalt. This leaked very badly and to overcome we applied an additional inch of asphalt, then covered with felt paper, following the Barrett specification for a paper roof.

This piece of waterproofing averages 60 ft. in width and is about 275 ft. long. Since repairs as above noted were made we have never had a leak.

Fig. 4 shows a typical section through a

and dry, and then to be thoroughly coated with a painting coat of asphalt cut with naphtha or gasoline. On this surface is to be laid $1\frac{1}{2}$ ins. of asphalt mastic made in proportion of 1 part of asphalt to 4 parts of clean sand. This is to be spread in place and well smoothed with smoothing irons. After this is completed, the entire surface is to be swabbed or mopped over with hot asphalt and sprinkled with sand. Concrete to be of composition $1:2\frac{1}{2}:4$, the stone to pass through a 1-in. ring with all crusher dust removed. Expanded metal to be laid across tops of floor troughs, and bent for gutters, joints to overlap at least 1 ft."

Mr. W. H. Finley, assistant chief engineer of the above company, adds to this information the following specifications and

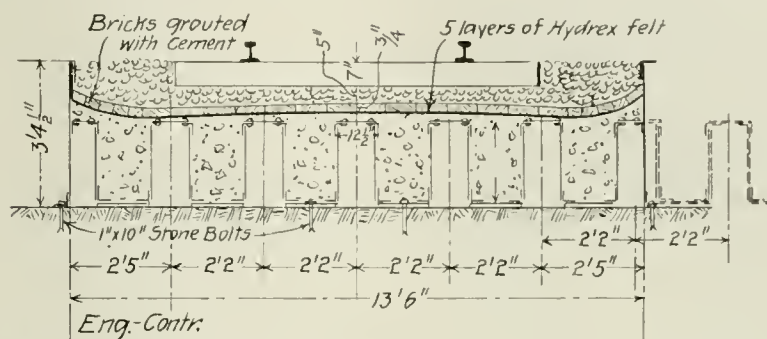


Fig. 4—Waterproofing Concrete Bridge Floor, Pennsylvania R. R.

trough floor system, in which you will note our method of waterproofing and its application.

*Chicago & Northwestern Ry. Co. (I. F. Stern).—*We use the trough system of floor, Fig. 5. Where a girder span is used we aim to prevent the water following the lines of the girder by flashing along the side of the girder with asphalt.

We have not had any particular trouble

instructions for waterproofing metal and masonry structures:

1. *Material.*—(a) Asphalt shall be used which is of the best grade, free from coal tar or any of its products, and which will not volatilize more than $\frac{1}{2}$ of 1 per cent under a temperature of 300° F. for 10 hours.

(b) It must not be affected by a 20 per cent solution of ammonia, a 25 per cent solution of sulphuric acid, a 35 per cent solu-

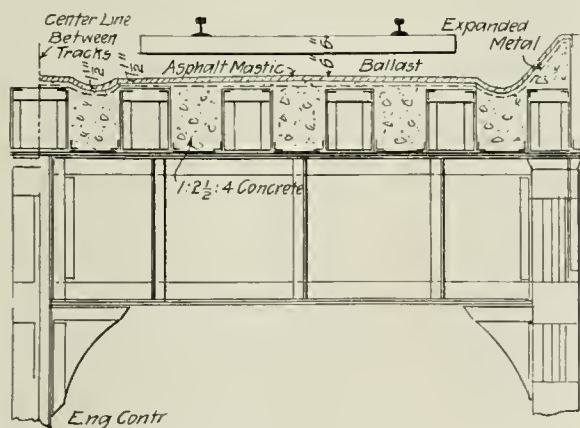


Fig. 5—Waterproofing Concrete Bridge Floor, C. & N. W. Ry.

the concrete, which has been smoothly troweled to provide proper drainage of water.

We protect our waterproofing by means of hard brick laid flat. After being laid it is thoroughly run with grout.

I know of no other method more satisfactory than the felt covering laid in either

on account of the expansion of metal cracking the concrete or waterproofing; we allow expansion joints.

After the surface is cleaned of dirt, a swabbing coat of asphalt cut with naphtha is put upon the concrete. The directions are as follows:

"The surface of concrete is to be clean

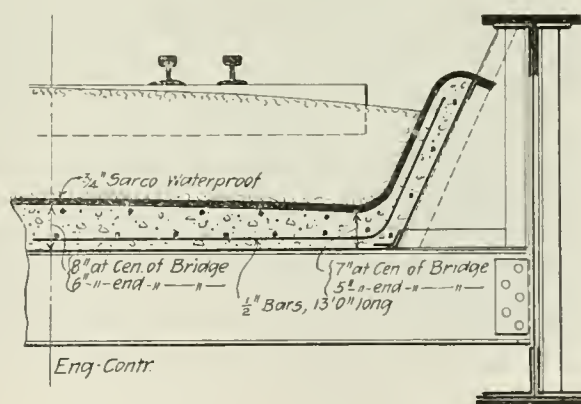


Fig. 6—Waterproofing Concrete Bridge Floor, L. S. & M. S. Ry.

tion of muriatic acid, nor by a saturated solution of sodium chloride. It should show no hydrolytic decomposition when subjected, for a period of ten hours, to hourly immersions in water with alternate rapid drying by warm air currents.

2. *Range of Temperature.*—(a) For metallic structures, exposed to the direct rays

of the sun, the asphalt must not flow under 212° F., nor become brittle at 0° F. when spread thin on glass.

(b) For structures under ground, such as masonry arches, abutments, retaining walls, foundation walls of buildings, subways, etc., a flow point of 185° F. and a brittle point of 0° F. will be required.

(c) A mastic made from either grade of asphalt by mixing it with sand must not perceptibly indent when at a temperature of 130° F. under a load of 20 pounds per square inch. It must also remain pliable at a temperature of 0° F.

3. *Preparing Surface.*—(a) Before applying asphalt to a metal surface, it is imperative that the metal be cleaned of all rust,

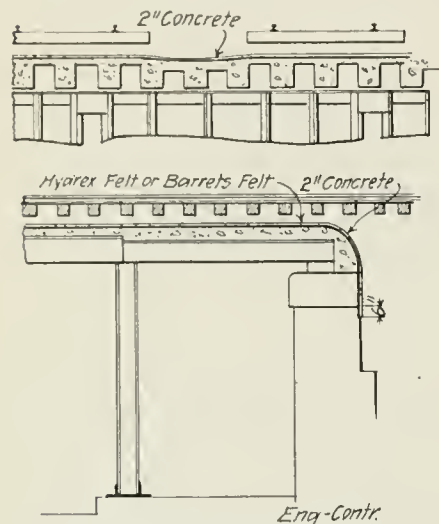


Fig. 7—Waterproofing Concrete Bridge Floor, Pennsylvania Co.

loose scale and dirt, and if previously coated with oil this must be burned off with benzine, or by other suitable means. The metal surface must be warm to enable the asphalt to adhere to it, and the warming is best accomplished by covering it with heated sand, which should be swept back as the hot asphalt is applied.

(b) When waterproofing masonry structures, if the surface cannot be made dry and warm, it should be first coated with an asphalt paint applied cold. This is particularly necessary for vertical surfaces. It is difficult to make either cold or hot asphalt adhere to the surface of concrete or mortar when the latter is covered with a thin film of cement. To overcome this the surface of the structure should be covered with a finishing coat of mortar composed of one part of cement to one part of sand. If this is not permissible the surface should be cleaned with a sand blast.

4. *Preparing Asphalt.*—The asphalt should be heated in a suitable kettle to a temperature not exceeding 450° F. If this is exceeded it may result in "pitching" the asphalt. Before the "pitching" point is reached the vapor from the kettle is of a bluish tinge, which changes to a yellowish tinge after the danger point is passed. If this occurs the material should be tempered by the addition of fresh asphalt. The

asphalt has been cooked sufficiently when a piece of wood can be put in and withdrawn, the asphalt clinging to it. Care should always be taken not to prolong the heat to such an extent as to pitch the asphalt; should it become necessary to hold the kettle for any length of time, bank or draw the fire and introduce into the kettle a quantity of fresh asphalt to reduce the temperature.

5. *Application of Asphalt.*—(a) The first coat should consist of a thin layer poured from buckets on the prepared surface and thoroughly mopped over.

(b) The second coat should consist of a mixture of clean sand or limestone screenings, free from earthy admixtures, previously heated and dried, and asphalt, the proportion of 1 part asphalt to 3 or 4 parts sand or screenings by volume; this is to be thoroughly mixed in the kettle and then spread out on the surface with warm smoothing irons, such as are used in laying asphalt streets. The irons should not be hot enough to burn the asphalt.

(c) The finishing coat should consist of pure hot asphalt spread thinly and evenly over the entire surface, and then sprinkled with washed roofing gravel, torpedo sand or stone screenings, to harden the top.

(d) The entire coating should not be less than 1 in. thick at the thinnest place.

Lake Shore & Michigan Southern Ry. (R. H. Reid).—We use I-beam construction for our solid floor bridges.

To prevent water following the line of girder and gussets we use a steel trough lined with concrete and protected with waterproofing; we use solid concrete filling between girders; we carry it up to the top flange and carry the concrete protection up beneath the top flange, as shown by Fig. 6.

We have not used solid concrete construction long enough to determine whether

we have taken out some old iron bridges in which transverse trough sections were used and filled with concrete in which the concrete was so firmly united that we have not yet succeeded in getting it out, although the trough sections have gone into the scrap pile. Apparently the concrete was in as good condition as when put in place.

In the way of general information will say that we have under construction at Keefe and St. Lawrence avenues, Chicago, at Park Manor Station, two bridges in which we have used steel concrete floor over I beams with the Sarco waterproofing.

Pennsylvania Co. (A. F. Miller).—In 1904 in the waterproofing of subway bridge floors we used at first asphalt covering $\frac{1}{4}$ in. thick over concrete. This was found to be ineffective on account of the contraction and expansion, and its liability to puncture. We then used an asphalt mastic made of asphalt and screening thoroughly mixed in kettles, and applied while hot and thoroughly tamped, after which a $\frac{1}{4}$ -in. layer of pure asphalt was poured over bridge floor on top of the mastic, forming a blanket covering; but on account of the shrinkage when cooling, thus defeating the purpose for which it was intended, its use was discarded on account of ineffectiveness.

The second method tried out by us was concrete, covering the joints of iron work with a substance known as iron bark, which was applied to the steel work of the bridge with hot smoothing or sad irons, which gave an excellent bond between the steel and the bark. Results very unsatisfactory, the contraction and expansion of steel floor tearing the bark, thus defeating the purpose for which it was intended, and its use was discontinued.

Third method: In the latter part of 1904, at one of our subway bridges on the

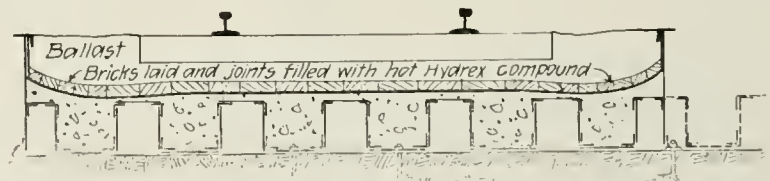


Fig. 8—Waterproofing Concrete Bridge Floor, Pennsylvania R. R.

we will have any cracking due to expansion and contraction. My opinion, however, is that we will have no trouble from this source.

We are now using a gum called Sarco, manufactured by the Standard Asphalt & Rubber Co. of Chicago, and we put on one layer $\frac{1}{2}$ in. thick, putting it on hot. In regard to the results obtained, will say that we hope for the best, but have not used it long enough to give a reliable opinion.

We do not use any felt covering over concrete.

We protect waterproofing from stone ballast and coarse gravel by a 3-in. layer of fine gravel or sand.

We are not at present using any other methods than those outlined herewith, but

P., C. & St. L. Ry., we made a test of a felt covering over concrete, using three-ply felt thoroughly mopped with a Hydrex compound, over which was placed a layer of concrete $1\frac{1}{2}$ ins. thick, sidewalk finish to protect the felt from stone ballast. This method has given us the best result. Care was taken not to allow any adhesion between the concrete and the felt over expansion joints, but was laid as a blanket over the concrete, thus allowing for any irregular contraction or expansion in the metal or concrete covering of the bridge floor proper.

In conclusion would say that the felt method has not given us an absolutely water-tight bridge floor, and that there is still room for great improvement along this line.

but we have received the best results from the felt system in our elevation work.

Mr. A. L. Bowman.—Method of Applying Waterproofing: First. The steel floor plate was thoroughly cleaned and painted with one coat of red lead and oil.

Second. A filler of Mastic Asphalt was placed along the webs of the girders.

Third. Five layers of Hydrex Felt cemented together with Hydrex Compound were then put on the floor plate and carried as far as possible up under the flashing angles, which were fastened along the webs and around the stiffeners and the ends of the girders. The felt was not cemented to the floor plate but was thoroughly cemented to the webs of the girders.

Fourth. A layer of brick laid flat was then placed on the felt in a hot layer of compound, the brick being laid lengthwise of the bridges.

Fifth. The joints between the brick were thoroughly poured with compound and the whole surface mopped with compound.

Sixth. The stone ballast ties and rails were then placed on the bridge.

Labor and Time on Waterproofing After Steel Work Was Erected: The skilled and common laborer employed per square (100 sq. ft.) was as follows: Foreman, 1.66 hours; waterproofers, 11.71 hours; laborers, 7.75 hours. The overtime to complete a floor of 750 sq. ft. was 1.4 days of 10 hours. The best time for one track, 750 sq. ft., was one day of 10 hours.

Cost: The cost of waterproofing materials per square foot of floor surface was 20¼ cts. The cost of labor per square foot was 10¼ cts. Materials per square (100 sq. ft.): Brick, 440; Hydrex Compound, 41.2 gallons; Hydrex Felt, 1.46 rolls (400 sq. ft. per roll).

Results: The bridges are watertight with the exception of a few points immediately over columns.

During a severe storm the water leaks down to some extent, between the main and side walk girders. It seems impossible to keep these points absolutely tight.

The vibration and reflection of the girders break the bond of any material which is placed between the ends of the girders. From a close observation of these bridges it seems impossible to make the compound adhere to the steel for any length of time, due to the vibration of the steel work and the hardening of the material during cold weather.

It is necessary to protect the edges of the waterproofing along the girders from water running down behind after the waterproofing has broken loose. This was done by means of the flashing angles referred to above.

No attempt should be made to fit the brick along the web or brackets, the brick being simply shoved as tight as possible and then the openings poured with the compound. Afterward the opening under

the flashing angles should be filled with concrete to keep the edges of the felt from curling over.

The felt was carried well over and down the back walls, drainage being had by putting the bridges on a grade and allowing the water to run behind the abutments, which were drained by pipes running through the abutments to the gutters.

Of the six bridges referred to above five were very near together and so were erected in one group. The sixth was quite a distance away and was erected separately, so as to throw as little track out of service as possible.

All track changes were made by means of crossovers at each end of the groups of bridges to be erected. These crossovers were operated by switchmen and operators stationed at each group. And in addition the signals governing them were incorporated in the electro pneumatic signal system of the road.

Method of Constructing Concrete Foundation for Street Railway Track Using a Special Mixer Mounted on a Car.

In its work of reconstructing its track in compliance with city ordinance the Chicago City Ry. Co., which owns and operates the surface lines on the south side, is making use of a traveling concrete mixing plant. This plant is shown in operation by the accompanying cut, and has worked

base. One track is rebuilt at a time. It is torn out and the excavation is filled to the proper level with the broken stone, which is rolled solid. The ties and rails are then laid and fastenings completed except that the joints are not welded. The concrete is then laid, leaving openings at the joints to permit welding, which is done electrically after the concrete has set for six or seven days. The paving is finally laid, completing the track. The following description relates alone to the work of laying the concrete foundation.

The mixing plant consists of a Chicago Concrete Mixer mounted on the end of a short flatcar. This mixer is a standard machine of its make except that it is fitted with an elevating charging skip on each side and has in addition to the regular vertical swing discharge spout a supplementary discharge spout arranged to swing horizontally. Both of these features are indicated clearly by the illustrations. The two elevating charging skips permit the mixer to be charged from either side; ordinarily only one skip is used at a time, the one next to the nearest curb. The idle skip is kept hoisted, in which position it comes within the standard clearance lines. The horizontally swinging spout enables the concrete to be discharged at any point across the full width of the foundation and directly into place. The mixer car is coupled to a motor flat car which moves the outfit along as fast as the work progresses. Two-way wheel barrow inclines attached to



Traveling Mixer for Concreting Street Railway Track Foundations.

with such satisfaction that a brief description of its construction and a record of its work are of interest.

The new track construction consists of girder rails on sawed cross-ties 6x8 ins. x 7 or 8 ft., resting on a sub-base of crushed stone compacted by a steam roller. On this sub-base is laid the 1-3-6 broken stone concrete foundation so as to imbed the ties and the rails to a level 2½ ins. above their

the mixer car and moving with it furnish the necessary runway for charging the skips. These inclines have a rise of some 18 ins. The mixer is operated by a 15-11 P. electric motor, which also operates the skip buckets through individual friction clutches.

The sand, stone and cement are piled along the nearest curb at close intervals and are charged to the skip by wheel barrows. The sand and cement are charged

together; the wheelers throw three or four shovelfuls of sand into the barrow, then empty a bag and a half of cement on it, and then fill the barrow with sand. Two barrows of the sand and cement mixture and three barrows of stone make a skipful of 13 cu. ft. The mixer has a batch capacity of $\frac{1}{3}$ cu. yd. The concrete is mixed fairly wet and is deposited outside of or between rails as desired by means of the swinging chute. Three men with shovels spread the concrete and level it off and four men with tamping bars, one working on each side of a rail, force the concrete compactly under the rails between ties. One man with a flat-face rammer then rams the concrete solid. Its top surface is then dusted with a dry mixture of sand and cement, which is made even and well brushed in with an ordinary stable broom, the sweeper sprinkling the top with a hose as needed. Another man thoroughly sprinkles the broken stone sub-base before any concrete is deposited.

The gang mixing and placing concrete is composed about as follows:

Duty.	No. Men.
Wheeling stone.....	9
Wheeling sand and cement.....	7
Wheeling bags of cement from piles.....	1
Helping dump barrows.....	1
Operating motor car.....	1
Operating mixer and skips.....	1
Operating discharge spout.....	1
Spreading concrete	3
Tamping with tamping bars.....	4
Ramming concrete.....	1
Dusting with dry mixture.....	1
Sweeping and sprinkling.....	1
Sprinkling stone sub-base.....	1
Foreman	1
Total	33

An 8-hour day is worked and some 500 lin. ft. of single track foundation are constructed per day. As the volume of concrete in the foundations runs about 1,650 cu. yds. per mile, the output of concrete in place is about 156 cu. yds. per day. With wages averaging \$2 per day this would make the labor cost of concrete in place $\$66 \div 156 \text{ cu. yds.} = 42\frac{1}{2} \text{ cts. per cu. yd.}$

The work described is being done under the direction of the Board of Supervising Engineers of the city of Chicago, Mr. Bion J. Arnold, chief engineer, by the Chicago City Ry. Co., Mr. C. A. Caul, general roadmaster.

According to a recent consular report, during the 30 years ended in 1906 only one passenger was killed on the railways of the United Kingdom in every 10,300,000 journeys, while one was injured in every 2,300,000. In 1907 the figures were one killed in every 70,000,000 and one injured in every 2,300,000.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Method and Cost of Gold Dredging by the Elevating Bucket.

The elevating bucket type of dredge has not been a favorite machine in the United States in the past. A number of this type of machine were brought by the French engineers to the Panama Canal when that work was being done under the French regime. During the past four years some of these dredges have been rebuilt by the Isthmian Canal Commission, and are doing excellent work, being preferred for some kinds of dredging to other types of machines.

Several elevating bucket dredges built in Scotland were brought to Canada for dredging the St. Lawrence river, and, since 1890, the Canadian government has built a number of these machines, and prefer them to the dipper type, as they do their work more regular, leaving a smoother and cleaner bottom. With different styles of buckets they are able to dig materials from soft clay to shale rock in ledges.

This style of dredge has been used in New Zealand for some years for gold dredging, and, a little more than a decade ago, the first one was tried in the California gold fields. The initial dredge in the California service was a very crude affair, but it proved profitable, with the result that a number of manufacturers began to build them, making great improvements in their construction and design, and increasing them in size. Today there is a large number of such machines at work in gold dredging, many powerful machines of this type being used in the Oroville district of California. The machine, besides digging the gold bearing material, also extracts the gold. To do this work they have a bucket line, mounted on a ladder generally made of steel, which takes up the material and delivers it into a hopper. From the hopper the material either goes into a revolving screen or over a shaking screen, which receives and washes the excavated material and rejects the stones. The coarse tailings and rejected stones are taken care of by the stacker, a belt conveyor that carries them out of the rear of the dredge, and stacks them in a pile. The gold bearing material enters a sluice box or falls on gold saving tables, in or on which the fine material is washed, and the gold saved. Pumps to supply water for washing and sluicing complete the machinery, except the power and lighting plant. In some cases steam furnishes the power, while in places where a number of dredges are operated in close proximity, it is generally found

cheaper to use electricity. As these dredges are worked, as a rule, 21 hours, lights are furnished, which are generally electric. Where electricity is used as the operating power, the hull need not be as long as when steam is used, as less space is needed for the machinery.

The bucket elevator style of dredge has been found very efficient for gold dredging. The dipper dredge will handle the material that the elevator bucket dredge handles, but, in digging, it so disturbs the gravel that much of the gold sinks to the bottom. Then, too, the door of the dipper is not water tight, and gold is lost in this way. When dipper dredges were used more extensively, attempts were made to make the doors tight by having them close against rubber packing, but this was not durable and it was never possible to get a hinge that would make the door close perfectly tight. Moreover, the dipper dredge brought up materials in large quantities at intervals, and it could not be handled to the gold saving machinery as economically as with the elevating dredge. An extra scow was generally needed, from which the material was handled to a hopper and thence to a sluice box or gold saving tables.

A clam shell or orange peel bucket worked on a gold dredge is also not economical on account of the buckets not being water tight. A hydraulic or suction dredge has not been successful at gold dredging, owing to the fact that boulders abound in many of the richest placers, and, as the gold is heavier than the gravel, the latter is sucked to the pump and elevated, while much of the gold is deposited on the bottom of the pit. The gold could be elevated by the pump, if it entered the suction pipe and passed through the pump into the riffles and was there caught. A rotary cutter would also agitate the gravel too much.

With the elevator dredge the action of the buckets is slow; in the close connected type the number dumped per minute ranging from 18 to 30, while with the link type from 12 to 14 are delivered per minute. The action being steady and quiet, the material is taken from the bottom without undue agitation, and as the buckets are water-tight they carry their entire contents of gravel, gold and water until inverted over the hopper.

The buckets are made of three sizes, 3, 5 and $7\frac{1}{2}$ cu. ft., respectively. The speed is generally about 50 ft. per minute, but in hard ground this is reduced about 25%, while in soft material it is sometimes increased 50%. The ladders carrying the

buckets are now built to excavate to as great a depth as 65 ft.

The hulls are built, either as two separate scows housed over into one, or as one scow with a large well in it. The buckets operate in this well, being swung from a gantry, by means of which the buckets are raised and lowered. Another gantry on the rear of the dredge holds the stacker. Such a dredge known as the "Hunter Dredge" is shown in the illustration.

This dredge was built by the Western Engineering & Construction Co., of San Francisco, Cal., at the Oro Water, Light & Power Co. The dredging machinery proper was manufactured by the Bucyrus Co., of South Milwaukee, Wis. Operation of the dredge was commenced in August, 1907, working placer ground 38 ft. deep from the water line to bed rock.

The entire plant embodies the latest type of construction, the hull being especially trussed along the well hole line with an overhead structure. The low gantry, supporting the digging ladder and buckets, is of the most improved design, being constructed to minimize warping of the low

means of which the digging ladder is raised and lowered; the other on the starboard side, carrying the auxiliary lines used in swinging the dredge from side to side. The digging ladder is held up hard and fast to the face of the cut by means of a steel spud 21x36 ins. and 50 ft. long. A wooden spud is also provided, of the same dimensions as the steel spud, and is chiefly used to move the dredge forward after bed rock has been cleaned, and a new cut is necessary. In this process, both spuds are alternately raised and lowered until the dredge has stepped ahead to the position required.

This machine is entirely operated by electricity. Electric power is delivered at the dredge at approximately 4,000 volts, being carried aboard by armoured cable at that voltage and stepped down with transformers from 4,000 volts to 400. The following motor equipment is used. The digging motor is a 100 H. P., type F, variable speed, operating as all the motors do at 400 volts, and having a speed of 600 R. P. M. It is connected by belt to the port winch, which drives the bucket line, and raises or lowers the ladder.



The "Hunter Dredge" for Reclaiming Gold Bearing Gravel.

pontoons. The buckets, each of 5 cu. ft. capacity, are close connected, and are provided with heavy, manganese steel lips. Altogether, there are 82 buckets in the chain.

A revolving screen, 6 ft. in diameter by 26 ft. long, having several sections of perforated plates, graduated to the size of the material handled, disintegrates the gold bearing gravel and clay under pressure from an 8 in. centrifugal pump. The gold is washed free from the gravel during its passage through the revolving screen, and is carried through the perforated plates onto a system of gold saving tables, suitably arranged underneath the screen. The tables are furnished with riffles made of wood and shod with iron. These catch the fine gold as it drops from the screen, and bring it into contact with quicksilver previously distributed over the tables, and with which it readily amalgamates. Large stones and boulders refused by the revolving screen are passed through a hopper and carried well astern of the dredge by means of a 30-in. endless Robins belt conveyor on the stacker.

There are two winches on the boat, both located forward; one on the port side, by

The motor connected with the starboard winch by a belt is of 20 H. P., type F, variable speed, having a speed of 900 R. P. M. By means of this motor and winch, the wooden and steel spuds are hoisted, the stacker raised and lowered, and the side and head lines in handling the dredge controlled.

The 8-in. centrifugal pump is direct connected to a 50 H. P. motor, type CCL, constant speed, having a speed of 850 R. P. M. A 15 H. P. motor of the same type with a speed of 1,120 R. P. M. is direct connected to the 4-in. centrifugal pump.

The revolving screen with a speed of approximately eight revolutions per minute is operated by a belt from a 20 H. P., type CCL, constant speed motor, having a speed of 1,120 R. P. M. The stacker motor is a 20 H. P., type C, constant speed, having a speed of 1,120 R. P. M., and connected by belt to the drive of the conveyor. As stated this is of the Robins type, equipped with a 30-in. special Diamond Dredge belt, the entire conveyor being 102 ft. between center. As originally installed it was only 90 ft., but it was found necessary to lengthen it.

All the electric motors were manufactured by the Westinghouse Co.

When all drives are being used 225 H. P. is needed, but this seldom occurs. The main drive motor, which operates the bucket line and ladder hoist, is in use nearly all the time. The starboard winch motor is used more or less intermittently, only when it is necessary to raise and lower the spuds, or the stacker, or swing the dredge from side to side. The pump motors are used constantly in supplying water for the revolving screen and tables, also for the bucket washing apparatus, where the buckets dump by inversion at the upper tumbler. Both revolving screen and stacker belt motors are constantly in use, the one driving the revolving screen or "grizzly," as it is commonly termed, for properly screening the gravel, the other in connection with the stacker belt, which carries off the tailings. The digging buckets average speed is about 22 buckets per minute, this naturally varying according to the nature of the ground.

From 90,000 to 110,000 K. W. hours are used per month on the dredge, making a daily rate of from 3,000 to 3,666 K. W. hours. The cost of current is 1 ct. per K. W. hour.

The entire cost of this dredge ready for operation was \$90,000.

Such a dredge is operated during a monthly average of from 80 to 90% of the possible running time. The dredge is operated 24 hrs. per day, with three 8-hour shifts. All stops of whatever nature are counted in the average time made; for break downs of machinery, power shut downs and for cleaning up. A clean up is made twice a month, usually taking up four or five hours. This time is not lost entirely as it is taken advantage of to make needed repairs. To obtain such running results, duplicates of all wearing parts must be kept on hand to be replaced with the least possible delay.

Such a dredge is operated with 2 men, one being a winchman, the other an oiler. Many of the dredges employ a shoreman to dig "dead men" and help in handling the shore line. In addition to these, most of the dredges carry a dredge master.

The wages paid these men are as follows:

Dredgemaster	\$150.00 per mo.
Winchman	3.50 per day
Oiler	2.50 per day
Shoreman	2.00 per day

The Hunter dredge, working 30 days in a month, excavated 106,000 cu. yds. of very hard material with a large number of boulders in it. The cost of this month's work was as follows:

Labor:	
1 Dredgemaster	\$150.00
3 Winchmen, 30 days	310.00
3 Oilers, 30 days	225.00
2 Shoremen, 30 days	120.00
Total	\$805.00

Power.	
100,000 K. W. hours.	\$1,000.00
Supplies, etc.	210.00
Plant:	
Interest, depreciation, and repairs (estimated)	1,800.00

Total cost\$3,815.00

This gives a cost per cu. yd., including our estimated allowance for plant, as follows:

Labor	\$0.007
Power	0.002
Supplies	0.002
Plant	0.017

Total\$0.035

This shows how wonderfully efficient these dredges are. It is also worthy of note how easily so small a crew operates so large

A Scraper Excavator with a New Form of Bucket.

A power scraper operated by cable-way was successfully used some dozen or more years ago on one of the earth sections of the Chicago Drainage Canal. Later a similar cable-operated scraper was used on the Massena Canal in northern New York state. From these machines and their successors there has been developed within the last five or six years a type of excavator known by various names, but consisting of a traveling derrick carrying a steel scraper bucket so operated by hauling line and hoist that it excavates by scraping and swinging between pit and spoil banks. This type of excavator has become quite popular and has been put on the market in various forms differing from each

terial is black soil overlying 8 ft. of stiff yellow clay, which overlies a fairly soft clay, which for the most part cuts nicely.

The excavator is shown at work by Fig. 1. It is a revolving derrick mounted on rollers, so that it can be moved along the berme on temporary wooden track. The construction is entirely steel. The boom is 85 ft. long and the A-frame mast is 35 ft. high and is guyed both forward and back to the steel frame. A topping lift varies the height and reach of the boom, which gives a maximum width of cut of 75 ft. when excavator is on berme. The scraper is operated by a hauling line and by a hoist in the manner described more fully further on. The bucket being used on this work is $3\frac{1}{3}$ cu. yds. capacity. The engine is a special $10\frac{1}{2} \times 12$ in. 3



Fig. 1—Power Scraper Excavator Working on Evanston Branch, Chicago Drainage Canal.

a machine. A company operating one or more of these dredges employs a blacksmith and helpers to make repairs and keep up the machinery, and also a superintendent who gives the work general supervision and is present at the semi-monthly clean ups. Many of these dredges, with fair paying gold gravel, yield large profits in the course of one or two years' operation.

The total of excavations for September on the New York State Barge Canal was 1,195,606 cu. yds.

The Chilean government is planning the construction of a number of government railways of an aggregate length of 852.3 miles. The railways will require 103 steel bridges and the construction of 17 tunnels. The total estimated cost is \$37,223,757.

other chiefly in the construction and operation of the scraper bucket. The accompanying illustrations show the latest of these excavators, known as the Heyworth-Newman excavator, and sold by James O. Heyworth, Chicago, Ill.

The views Figs. 1 and 2 show the excavator at work on the Evanston branch of the Chicago Drainage Canal on an 880,000 cu. yd. contract held by Mr. Heyworth. The Evanston branch canal has a bottom width of 30 ft., with side slopes of 3 on 5, and an average depth of 30 ft. The spoil is being put on both sides of the canal with 25-ft. berme between canal and spoil banks. The plan of operation is to work the excavator along one side of the canal, taking out the material to the center line and then work it along the opposite side, removing the remainder of the excavation. The ma-

drum engine with steam operated frictions built by the Monighan Machine Co. of Chicago, Ill. One drum operates the hoist, one operates the hauling line and one the boom fall. A separate swinging engine is used to revolve the derrick. One engine man operates both engines from a platform at the front, from which he can see the bucket at all times.

The bucket is shown clearly by Fig. 2; its distinctive feature, which incidentally eliminates wear on pins, etc., is the stiff bail, which is also adjustable to various angles with the plane of the bucket bottom. This permits the depth of cut to be adapted to the material and prevents the bucket from riding over hard material. The attachment of the bail is quite clear from the illustration. It is pivoted to two links attached to the bucket sides near the bottom and these links are ad-

justable. Two other links connect the bail about midway of its length with the top edge of the bucket, and these links can be shortened or lengthened by taking up or letting out the links one or more holes, as shown. The total possible variation in the angle of the bail is about 30°. To prevent the bail from gouging into the ground it has wide runner or shoe on its under side near its outer end. The bucket is made of $\frac{3}{8}$ -in. tank steel in the body; the mouth piece is 1-in. steel plate cut to a V-shape.

The bucket is operated by two lines. The hauling line runs direct from the end of the bail to the hauling drum of the engine. The hoisting rope, as will be seen from the illustration, forms a sling in which the bucket is suspended. In hoisting the hauling rope is let slack and

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

The Destructive Effect of Automobiles Upon Macadam and the Use of Asphaltic and Tar Binder in Road Building.

The most important feature of the recent Good Roads and Legislative Convention at Buffalo was the unanimity of opinion among road builders that some sort of asphaltic or tar binder must hereafter be

can afford to do it, with my age, that all our practices and all our experience in road construction and road maintenance are to-day of no avail; with the enormous travel, and the automobile travel, it is almost impossible to keep our roads in the state they were four or five years ago. The engineers have examined into the necessities of some substance or some mode of procedure that will keep these roads in good shape. We have tried the oil and we have tried the tar, and my experience to-day is this, that the only successful effort in keeping a good macadam road in repair is by the proper application of certain preparations of tar. This matter is now under discussion—was under discussion a week ago or so by the National Society of Engineers, and the conclusion arrived at was that that probably was the only good, safe material. The matter is to be discussed by an international convention in Paris in November, and I think it will be found that some medium other than water is necessary.

* * *

And I wish to say this, that I am going to retire as quickly as possible from hard-road construction. You want an elastic road; you want a road that has resiliency, that won't be ground up by the horses' feet or the wagon tires or the automobile. The other extreme is the construction of the roads in California. They cover them with shell and sprinkle them twice a year with the heavy Southern asphalt oil. Now, there are the two extremes of road; those do not wear out; and the idea that I had in my mind to-day is that future road development depends on the establishment of roads that won't wear. If you have no wear, you have no dust and no maintenance, and that is the ideal proposition. Now, my suggestion is that instead of working along on the theory that you have, we ought to work on theory of these elastic roads.

The other thought is this, that in the construction of congested traveled roads the bonding material should be some artificial product. I do not throw this out inadvisedly. Curiously enough, one State to-day is now building their roads with a tar mixture, and the State Engineer estimates that the extra cost of making that tar road—not putting it on the surface, but incorporating it as a constructive part of the road—is 13 cts. a square yard extra to what the ordinary macadam would be."

Mr. Abbott's Opinion. To Mr. James W. Abbott, late U. S. Highway Commissioner for the Rocky Mountain and Pacific Coast States, belongs the honor of having

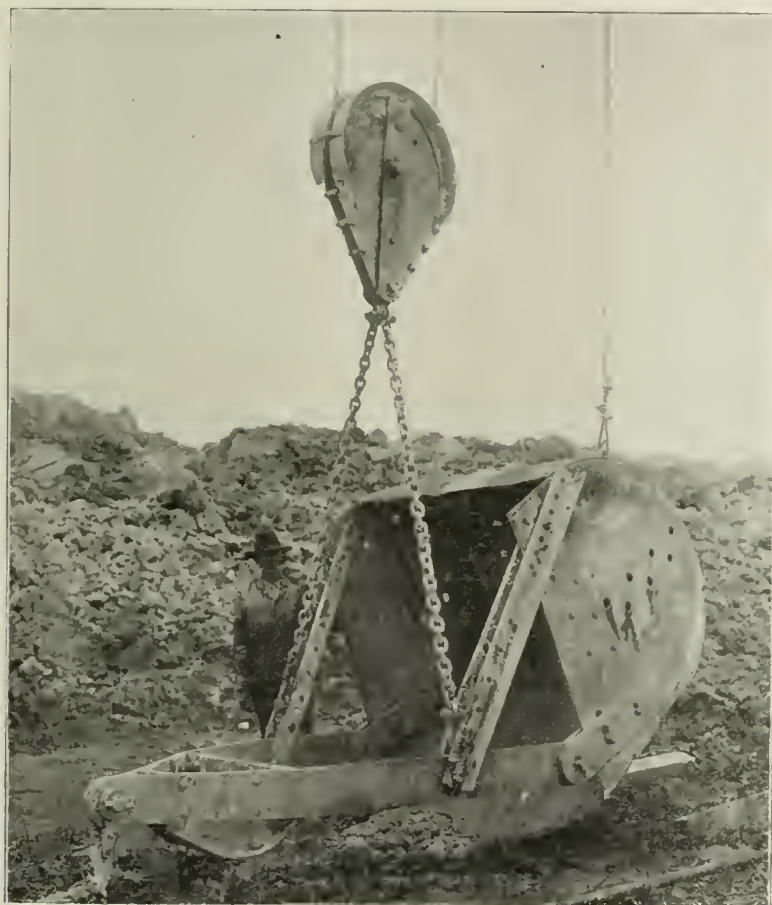


Fig. 2—Scraper Bucket for Power Scraper Excavator.

the bucket is hoisted "level" until the block strikes the stop on the boom, further hoisting then tilts the bucket bottom-up by continuing the pull on the rope attached to the rear of the bucket. The hauling rope does not have to be kept taut during hoisting.

The excavator is operated by one engineman and one fireman, and three men to prepare track and work around the machine. On the Evanston branch canal work the machine is operated three 8-hour shifts, but only two 12-hour shifts of trackmen are worked. It is taking out 1,800 cu. yds. per 24 hours.

used in road building. In our issue of Aug. 19 we reprinted the important paper of Mr. L. W. Page, Director of the Office of Public Roads in the Department of Agriculture, on the effect of automobiles upon macadam roads. In this issue we give abstracts from other noteworthy addresses delivered at the Buffalo convention, bearing upon the same subject.

The Nestor of road building in America is Mr. James E. Owen, of Newark, N. J., who gave the following as his opinion:
Mr. Owen's Opinion.

"Now, I have to confess, and I think I

been the first engineer to write a full description of the wonderful road work done in California with asphaltic oil. This he did in a historic article published in the 1902 Year Book of the Department of Agriculture. The following is an abstract of Mr. Abbott's address:

"The only thing that I have time to say to you is, that I believe that finally, after five or six or seven years of study, they have solved the question of how road builders may use a hydro-carbon (asphaltic oil—Editor) with the natural soil to make a permanent roadway cheaper than the macadam road; cheaper than any first-class road that has ever been built, and which shall be durable and at the same time shall be more efficient for all kinds of general traffic than any other kind of road that has ever been built. They are actually doing that now in the State of California. If any of you are in that State you will find Los Angeles the center of this work; you will find not less than forty different roads built on that principle. There is no patent on it; there is no royalty charged for building it; anybody who wants to go into the contracting business can build it. All he has to do is to buy himself a tamping roller. The theory is to take this hydro-carbon and mix it with the common surface of the earth and so thoroughly incorporate the hydro-carbon cementing liquid with the road surface that it is all together, and then to tamp it down with points of these rollers, which resemble in their action the feet of sheep, until you get a road tamped down so hard that it becomes practically a cement."

Mr. Pardington's Opinion. Mr. A. R. Pardington, General Manager of the Long Island Motor Parkway, after describing the building of a stretch of concrete roadway for automobiles, known as the Hassam Paving, said:

"In addition to the Hassam Paving, we are studying with great care the use of petroleum compounds in connection with local material; Peekskill gravel; Georgia gravel; loam, clay, etc. We are especially interested in and are giving all possible consideration to the type of road construction which prevails in California, where oil is injected, under pressure, into the earth, which has previously been plowed and later tamped by a special form of tamping roller which packs the mass from the bottom up. This type of construction has many attractions for us, and as soon as we are assured of the fact that it will withstand the rigors of the Northern climate, I am more than justified in saying that its use will be undertaken."

Mr. McDonald's Statement. Mr. James H. McDonald, Highway Commissioner for the State of Connecticut, said:

"Referring to the splendid roads on the other side, alluded to this morning, and which have been the admiration of the world for their grandeur, smooth condition, and durability, my friend Page told

me, not five minutes before I came on the platform, that they are sending over from France to-day inquiring what they shall do, after having expended \$600,000,000 on 24,000 miles of road, by reason of the fact that since the introduction of the automobile, if something is not done to remedy the havoc that is being wrought by the automobile, they will lose the entire principal.

"With all the education commissioners have had, with all the experience we have gained both in a personal way by research, investigation and reading, every commissioner in this country to-day is confronted with this great problem of what we are to do with the roads that we have in our charge."

Mr. Hunter's Opinion. Mr. Joseph W. Hunter, Highway Commissioner of Pennsylvania, expressed himself as follows:

"The general method of road construction that has been in vogue since the days of Macadam and Telford had proven satisfactory in the past, and will, under all ordinary circumstances, sustain the traffic that passes over it; but, since the advent of the automobile, it has been found that this form of construction—either macadam or telford-macadam—will not withstand the traffic of the heavy, rapidly moving motor. The automobile is here to stay and the use of motor vehicles will increase, rather than diminish, and it is for the various State Highway Departments to ascertain the best methods of road construction, that will not only meet the requirements of the automobile traffic but at the same time be satisfactory to the ordinary horse and wagon traffic. Brick-paved roads have been suggested and have many advocates. They will answer for the heavy teaming and automobile traffic, but for the ordinary traffic and light driving they are not satisfactory; the first cost is fully two-thirds more than an ordinary telford-macadam road. The annual cost of maintenance will be less, unless they are absolutely neglected by those whose duty it may be to care for and maintain them. A brick road will practically have to be rebuilt in twenty to twenty-five years, according to the uses to which it has been subjected. The dust preventives, oil, tar, or asphalt, have their uses, but are not permanent, and, unless the physical conditions are perfect, the practical results are nil. The only, and safe and economical, method is to incorporate the dust preventive and bonding material with the material used in the road construction."

Mr. Beman's Opinion. Mr. R. D. Beman, Deputy Highway Commissioner of Pennsylvania, was positive in his belief that surface treatment will never prove satisfactory. He said:

"Neither do I believe that any form of surface treatment will ever be found entirely satisfactory or economical. I am convinced from my study of the subject that the asphaltum or tar should be in-

corporated in the macadam during the construction of the road.

"One of the sources of complaint against automobiles is that popularly known as the 'dust nuisance.' This suggests to the road-builder not only the condition thus described, but what is of vastly greater importance, the rapid loss of valuable road material. I believe that all the observant automobilists will agree that automobiles damage macadam roads to a greater extent and destroy them more rapidly than any other vehicle which traverses them. The rapid movement is partly responsible, as it produces a partial vacuum into which the air rushes from every side, lifting, as it does so, the fine dust from the road surface and placing it at the disposal of any breeze which may be blowing. The greater part of the destructive effect, however, I believe, is due to the friction caused by the tractive force applied to the rear wheels, combined with the suction of the rubber tires. When compressed under heavy weight the convex surface of the tire becomes to some extent concave, its convexity being reversed and forced inward, and a close approach to a perfect vacuum being produced.

"How may we preserve the valuable road surface which is now blowing away in dust? It may be too early to predict the exact method by which the desired result will be reached, but I have been much impressed with the experiments with tar and oils containing asphaltum. It is well established that Pennsylvania petroleum, which has a paraffine base, is not adapted for such purposes, and I believe that some of the asphaltum oils sold for road use by various oil companies would be much more valuable if they contained less of the volatile elements and possessed more 'body.'"

Mr. Johnson's Opinion. Mr. A. N. Johnson, State Engineer of Illinois, outlined briefly the building of experimental roads in his state, following, in general, the methods used in California. He said:

"We are carrying on what promises to be some very valuable experiments in the construction of earth roads, combining oil and tar with the earth. Some similar work has been done, particularly in California, but this treatment has never been attempted in a climate similar to that of Illinois on black gumbo soils. It is believed, however, that with proper preparation of the roadbed and thorough rolling, that an impervious covering of the roadbed would be obtained. Its durability remains to be tested.

"Such roads, if it is possible to construct them, would doubtless answer even better than macadam roads for most country traffic and would meet much better the needs of the increasing motor travel, for it is evident to-day that unless some elastic, adhesive binder is used in the construction of macadam and gravel roads that the durability of these roads is of very short duration, even with but a moderate amount of motor traffic."

Amount of Materials Required for Cement Sidewalk Construction.

The great majority of cement sidewalks come within the range of 3 ins. to 7 ins. in thickness; the most common base mixtures are 1-2-5 and 1-3-6 and the most common finishing mixtures are 1-1, 1-1½ and 1-2. The accompanying tables have been computed to give by simple arithmetic, the volume of concrete and the quantities of cement, sand and stone required per 100 sq. ft. of sidewalk, ranging from 3 ins. to 7 ins. thick and constructed of the above named mixtures. Table I gives separately the volume of base concrete and of surfacing mortar in 100 sq. ft. of walk of the different thicknesses; Table II gives for each of the thicknesses and mixtures named the amount of cement, sand and stone required per 100 sq. ft.

The tables have been calculated on the assumption that—the cement being measured loose as is usual in sidewalk work—a barrel of cement measures 4.4 cu. ft. For finishing mortar the voids in the sand amount to 45 per cent; for base concrete the voids are assumed to be 40 per cent for sand and 45 per cent for broken stone. On these assumptions according to the theory of proportioning and the tables of mortar and concrete quantities given in "Concrete Construction—Methods and Cost," by Gillette and Hill, the amount of materials per cubic yard of mortar and of concrete are as follows:

Mortar proportions ..	1-1	1-1½	1-2
Barrels of cement....	3.94	3.34	2.90
Cubic yards of sand..	0.6	0.8	0.9
Concrete proportions.1-2-5			1-3-6
Barrels cement	1.16		0.90
Cubic yards sand.....	0.38		0.44
Cubic yards stone....	0.95		0.88

Table II has been computed from the above quantities and those given in Table I; thus for a 3-in. base (Table I) 0.93 cu. yd. of concrete is required per 100 sq. ft.; if the base be a 1-2-5 mixture, then the

crete Construction—Methods and Cost," the volumes given in Table I can be used as just exemplified to compute a table similar to Table II, but based on the preferred table of quantities per cubic yard.

Table II is used in estimating as follows:

Problem: Find the amount of cement, sand and stone required for 1,000 ft. of sidewalk 5 ft. wide; base 4 ins. thick of

Table I—Showing volume of concrete base and mortar wearing surface per 100 sq. ft. of cement walk of various thicknesses.

Concrete Base.	Mortar Wearing Surface.
Thickness, ins.	Thickness, ins.
Volume, cu. yds.	Volume, cu. yds.
2½	½
3	¾
3½	1
4	1¼
4½	1½
5	1¾
6	2
	0.155
	0.232
	0.309
	0.386
	0.464
	0.541
	0.618

Note.—100 sq. ft. of walk 1 in. thick has a volume of 0.309 cu. yd. To get the volume in a walk of any thickness, multiply 0.309 by the thickness of the walk in inches, e. g., 0.309 cu. yd. × 6 ins. = 1.87 cu. yd.

1-2-5 concrete; wearing surface 1 in. thick of 1-1½ mortar.

From Table II we have:

	Cement.	Sand.	Stone.
Per 100 sq. ft.	bbls.	cu. yds.	cu. yds.
Base, 4 ins.....	1.43	0.47	1.18
Wearing surface 1 in.	1.03	0.247	...
Total per 100 sq. ft..	2.46	0.717	1.18
	50*	50	50

Total per 5,000 sq. ft. 123.00 35.850 59.00

*1,000 × 5 = 5,000 ÷ 100 = 50.

A ton of copper pipe collected from old French excavators and locomotives, some bronze bearings taken from cars, locomotives and excavators, and 200 pounds of tin found in one of the old French warehouses, have been collected and will be sent to the Philadelphia Mint, to be used in casting the bronze metals which are to be presented by the President to employees of the Isthmian Canal Commission, who have served two years or more

Cost of Unloading and Hauling Crushed Rock.

The following data relate to the unloading and delivery of crushed rock. There was a macadamized or paved road from the unloading track to the beginning of the rock delivery. The road had low gradients, the worst being one hill 500 ft. long with 5 per cent grade to pull loaded. The average haul was 8,855 ft. The number of cars unloaded was 26, making 409 wagon loads. The railway weight of the crushed rock was 1,582,700 lbs. and railway weight of screenings 264,000 lbs. The crushed rock weighed 2,100 lbs. per cubic yard, the total amount being 753.6 cu. yds.; screenings weighed 2,425 lbs. per cubic yard, and there were 108.1 cu. yds. The scale of wages was as follows:

	Per Hour.
Shovelers	\$.20
Teams and driver.....	.40
Foreman (allowed).....	.40

The cost of unloading and hauling was as follows:

	Per Cu. Yd.
Shovelers	\$0.0923
Teams	0.3322
Foreman	0.0580
Blacksmithing	0.0418

Total\$0.5243

In explanation of the blacksmith's bill it may be stated that the tires had to be set all round on eight dump wagons with 4-in. tires. A good rain at the beginning of the job would have saved 90 per cent of that expense.

The storage magazine for explosives at Mindi, Isthmian Canal Zone, has been completed, and the work of storing dynamite has been begun. The magazine is built into the hillside in such manner that at the back and sides it is surrounded by earth. Hollow concrete blocks 12 in. thick and bullet proof have been used for the walls, and the roof is composed of concrete reinforced with old Belgian rails and waterproofed. The magazine is 112 ft. long, 48 ft. wide, and 9 ft. high inside. Ventilation has been provided by air flues which open under the roof. The magazine has a capacity of 600,000 lbs. of dynamite. Near the magazine, and yet so far away that an explosion in one would not affect the other, is a detonator house. It is 33 ft. 6 in. long, 17 ft. 3 in. wide, and 10 ft. high inside. It also is built of concrete blocks and has a ceiling of reinforced concrete with a corrugated iron roof above it.

The Chilean government is calling for bids for the construction of a section of railway from the port of Arica to alto de La Paz, an extension of about 460 kilometers. Bids are also being asked for constructing an extension from La Ligua to Copiapo, a distance of 680 kilometers.

TABLE II.—SHOWING QUANTITIES OF CEMENT, SAND AND BROKEN STONE REQUIRED FOR 100 SQ. FT. OF SIDEWALK SEPARATELY FOR BASE AND FOR SURFACE FINISH FOR DIFFERENT PROPORTIONS OF CONCRETE AND DIFFERENT THICKNESSES OF WALK.

	—1-2-5—			—1-3-6—				—1-1—			—1-1½—			—1-2—		
Thick- ness, ins.	Ce- ment, bbls.	Sand, cu. yds.	Stone, cu. yds.	Ce- ment, bbls.	Sand, cu. yds.	Stone, cu. yds.	Thick- ness, ins.	Ce- ment, bbls.	Sand, cu. yds.	Stone, cu. yds.	Ce- ment, bbls.	Sand, cu. yds.	Stone, cu. yds.	Ce- ment, bbls.	Sand, cu. yds.	Stone, cu. yds.
2½	0.89	0.29	0.73	0.69	0.34	0.68	½	0.61	0.093	0.52	0.124	0.45	0.139			
3	1.08	0.35	0.88	0.84	0.41	0.82	¾	0.91	0.139	0.77	0.186	0.67	0.209			
3½	1.25	0.41	1.02	0.97	0.47	0.95	1	1.12	0.185	1.03	0.247	0.90	0.278			
4	1.43	0.47	1.18	1.12	0.55	1.09	1¼	1.52	0.232	1.29	0.308	1.12	0.347			
4½	1.61	0.53	1.32	1.25	0.61	1.22	1½	1.83	0.278	1.55	0.371	1.34	0.418			
5	1.79	0.59	1.47	1.39	0.68	1.36	1¾	2.03	0.325	1.81	0.433	1.57	0.487			
6	2.17	0.71	1.78	1.58	0.82	1.64	2	2.33	0.371	2.06	0.494	1.79	0.556			

Cement = 0.93 cu. yd. × 1.16 bbl. = 1.08 bbl.

Sand = 0.93 cu. yd. × 0.38 cu. yd. = 0.35 cu. yd.

Stone = 0.93 cu. yd. × 0.95 cu. yd. = 0.88 cu. yd.

The final results are the quantities given in Table II; and the other quantities given in this table are obtained in a similar manner. Should the user prefer different tables of quantities of materials per cubic yard of concrete than those given in "Con-

on the Isthmus. It is expected that the medals will be ready for distribution early in 1909, states the Canal Record. The design of the medals and the method of their distribution have not yet been determined.

Up to the end of 1905 there were 41,482 English miles of railroad in Russia; the average cost of construction was \$42,962 per mile.

Water-works and Sewer Section

Note: This section is devoted to methods and costs of constructing sewers and water-works. It will cover the construction work for all details of water supply and sewerage, including sewage purification and water filtration.

Unit Cost of Laying 107,877 ft. of Watermains at Cleveland, O.

During 1907 the Pipe Laying Department of the Division of Water Works of Cleveland, O., laid 107,877 ft. of watermains, the sizes of pipe and lengths laid being as follows:

30-in.	5,330 ft.
24-in.	11,161 ft.
20-in.	1,665 ft.
12-in.	17,362 ft.
10-in.	1,181 ft.
8-in.	15,099 ft.
6-in.	53,415 ft.
4-in.	439 ft.
3-in.	2,222 ft.

The accompanying tabulation taken from the annual report of the Water Works Division of the Board of Public Service, M. E. Bemis, superintendent of water works, shows the unit cost of laying these water mains.

The report states that the costs were

4-in. valves	7.63
6-in. valves	12.60
8-in. valves	18.90
10-in. valves	26.25
12-in. valves	31.50
16-in. valves	66.15
20-in. valves	134.25
24-in. valves	217.50
3-in. hydrants	\$20.00
4-in. hydrants	27.75
6-in. hydrants	46.25

Pig lead, first half of 1907.....

123.30 per ton f. o. b. point of shipment

Pig lead, second half of 1907.....

\$101.00 per ton f. o. b. cars at Cleveland

Packing 4¾c per lb.

The wages paid for labor were as follows:

	Per hour.
Foreman	\$0.42
Assistant foreman	0.33
Calkers	0.27½
Labor	0.22
Team	0.50

TABLE SHOWING THE COST PER FOOT OF 107,877 FT. WATERMAIN LAID DURING 1907.

	30-in.* per ft.	24-in.* per ft.	20-in.* per ft.	12-in. per ft.	10 in. per ft.	8-in. per ft.	6-in. per ft.	4-in. per ft.	3-in. per ft.
Pipe and specials.....	\$5.486	\$4.234	\$3.565	\$1.649	\$1.402	\$.958	\$.708	\$.463	\$.329
Valves	.139	.167	.281	.126	.203	.070	.051	.062	.021
Hydrants	.000	.000	.000	.103	.268	.107	.082	.069	.000
Lead	.354	.312	.222	.141	.165	.087	.064	.050	.025
Miscellaneous material	.090	.106	.084	.167	.011	.026	.014	.039	.002
Total material	\$6.069	\$4.819	\$4.152	\$2.186	\$2.049	\$1.248	\$.922	\$.683	\$.377
Foreman and asst. foreman	.074	.082	.086	.061	.093	.044	.042	.045	.013
Waterboy, teaming and watching	.126	.129	.140	.072	.105	.083	.044	.068	.006
Calkers and laborers	.750	.788	.629	.676	.516	.463	.450	.407	.150
Total labor	\$.950	\$.999	\$.855	\$.809	\$1.014	\$.590	\$.536	\$.520	\$.169
Total cost per foot.....	\$7.019	\$5.818	\$5.007	\$2.995	\$3.063	\$1.838	\$1.458	\$1.203	\$.546

*On 30-in. mains 24-in. valves were set and on 24-in. and 30-in. mains 20-in. valves were set.

†Includes paving and other items of like nature.

rather high, owing to the unusually high prices of materials prevailing during the year. The prices for materials at Cleveland, during 1907 were as follows:

	Per ton.
All sizes of cast iron pipe, delivered on streets, for the first half of 1907.....	\$36.25
For the second half of 1907.....	36.00
Miscellaneous castings and special castings, from 3-in. to 16-in., inclusive, first half of 1907.....	51.00
Miscellaneous castings over 16-in., first half of 1907.....	60.00
Miscellaneous castings, second half 1907	59.90
Special castings, from 3-in. to 16-in., inclusive, second half 1907.....	65.00
Special castings, over 16-in., second half 1907	75.00
	Each
3-in. valves	\$ 6.53

The Fifth Annual Convention of the National Association of Cement Users is to be held at Cleveland, O., during the week of Jan. 11, 1909. The headquarters and meetings of the convention will be at the Hotel Hollenden, and the exhibits of cement products and appliances will be held at the Central Armory, which is about two blocks from the Convention Hall. Applications to be considered in the first allotment of space in the exhibition hall must be received at the office of the association, Harrison bldg., Philadelphia, by noon Nov. 16, 1908.

The total number of passengers and railway employes killed in 1907 on the railways of the United Kingdom was 1,117 and the number injured was 8,811. In the ten previous years there was an average of 1,160 killed and 6,765 injured.

Compacting a Reservoir Embankment with a Petrolithic Rolling Tamper.

In building a small storage reservoir, Mr. Stephen E. Kieffer, M. Am. Soc. C. E., of Berkeley, California, recently used a Petrolithic rolling tamper with excellent results.

Mr. Kieffer says:

"The material used was a moist clay that packed very thoroughly, and when tamped with a rolling tamper became as hard as stone. The finished bank was so compact that it was a very expensive matter to dress it up to the true slopes because of the hard picking. No oil was used, but the roller was kept traveling around the reservoir constantly, and, as fast as the material was spread out in thin layers over the bank, it was tamped down.

Unquestionably, as a means of making an exceedingly compact and solid embankment, this rolling tamper beats any other means of accomplishing such work that I have ever seen or used."

Of course it is necessary to have the right percentage of moisture in the earth to secure the most effective packing under the iron feet of the rolling tamper.

Mr. Kieffer has suggested the treatment of the side slopes of a dike or reservoir with asphaltic oil tamped down with a rolling tamper, thus producing, in effect, a Petrolithic pavement. There are many kinds of earth that do not contain sufficient clay or loam to be watertight, no matter how thoroughly they may be tamped or rolled. In such cases a lining of some sort is imperative. Irrigation canals and ditches in California have been effectively treated by a surface sprinkling of asphaltic oil, but it is obvious that such a treatment would not be as effective as would result from a thorough mixture of soil and asphaltic oil, followed by consolidation with the rolling tamper.

In the Sacramento and San Joaquin Valleys there are many miles of dikes, which are frequently overtopped by high water, resulting in a flooding of agricultural lands that causes destruction amounting to many hundreds of thousands of dollars. Mr. Kieffer has suggested that the top of these dikes and the *outer slopes* might profitably be treated with asphaltic oil tamped in with a rolling tamper. Then a slight overtopping of a dike by water would not evade a disastrous crevasse.

It would appear desirable to treat the inner slopes of the dikes in the same manner, particularly at bends in the rivers, to prevent erosion.

In these two California valleys, the width of the levees has been steadily increased, until it is not uncommon to find a levee 175 ft. wide at the base, although it may not be more than 20 ft. high above the land level, as, for example, along Steamboat Slough on Grand Island, Sacramento Valley. The body of this particular levee is peat and sediment. Such material could be

wonderfully consolidated with a rolling tamper, rendering it unnecessary to use embankments of such great width.

In using a roller of this sort upon the slope of an embankment, it will be necessary to operate it by means of a portable hoisting engine. A small hoisting engine on trucks will readily pull one or more rolling tampers up the slope of an embankment, and then the rollers can be allowed to run back to the bottom by gravity. Instead of a hoisting engine, a traction engine can be used, by passing the rope from the roller around a snatch block at the top of the embankment, the snatch block being anchored to a deadman. The deadman need not be shifted frequently, for the snatch block can be fastened on to the end of a rope which is paid out as the rolling progresses along the embankment.

The Cost of Sewers in a Canadian City*

In Canada it is seldom that sewer construction work is now awarded according to unit prices. A certain section is now designated and bulk tenders called for. During 1907 the city of Sydney, N. S., laid some 6,570 ft. of sewer. The sections were of various lengths, and the size and depth of sewer varied. The following table gives the cost of 16 sections. Laborers were paid 17½ cts. an hour and foremen were paid 40 cts. an hour.

Cost per Lineal Foot.

Length in feet.	Size, ins.	Average depth, ft.	No. of manholes.	No. of lampoles.	Labor.	Materials.	Total.
111.3	8	7	1	1	\$0.668	\$0.370	\$1.04
297.5	8	7.5	1	1	0.711	0.354	1.06½
271.7	8	10.9	1	1	1.224	0.394	1.62
72.0	8	10.5	1	1	1.116	0.329	1.44½
142.5	8	8.5	1	1	0.936	0.329	1.26½
250.0	6	7	1	1	0.817	0.317	1.13½
83.3	6	7.5	1	1	0.688	0.201	0.89
*568.7	8	10.8	1	1	2.169	0.690	2.86
†1350.3	15	8	6	1	1.023	0.862	1.88½
93.0	18	7	1	1	0.637	1.257	1.89½
90.9	24	7.7	2	1	1.106	1.737	2.84½
754.9	15	9.3	3	1	1.357	0.789	1.94½
831.9	12	9.3	3	1	1.051	0.756	1.81
390.5	8	8.2	1	1	0.939	0.474	1.41½
145.0	24	7	1	1	2.425	2.284	4.71
1219.0	24	5.6	6	1	1.860	2.420	4.28

*Clay with 50 per cent rock.

†Clay with 30 per cent rock; all other trenches in clay.

An investigation of clays and clay products needed in government work is to be undertaken at once by the Technologic Branch of the U. S. Geological Survey. A ceramic section has been created with A. V. Pleininger, of Champaign, Ill., as ceramic chemist. The first investigation undertaken by the section will deal with the testing of burnt clay products. It is intended to study the relation between the true crushing strength of commercial bricks and their porosity, the object being the establishing of a technical definition for a good building brick.

Estimates for the Isthmian canal for the fiscal year ending June 30, 1910, call for an appropriation of \$35,000,000.

Bridges, Buildings and Foundations

Note: This section is devoted to methods and costs of constructing steel and masonry bridges and buildings and of foundation work of all kinds. It will give special attention to erection plant and tools, falseworks and centers and cost data of all kinds.

Data of Weight and Cost of Five Steel Arch Bridges.

In our issue of Sept. 2 we gave data on 32 concrete and reinforced concrete bridges, giving the concrete yardage, or cost, or both, of each bridge. This was followed in our issue of Sept. 23 by an article entitled "The Weights of Steel Bridges for Highway, Railway and Electric Railway Spans of 10 ft. to 300 ft." In our issue of Oct. 7 appeared another similar article, giving weights, costs, etc., of 14 steel bridges of ordinary truss and cantilever designs, but mostly of very long spans.

The following data relate to five steel arch bridges, and will be followed in a subsequent issue by similar data on suspension and bascule bridges.

Weight of an 840 ft. Span Arch Bridge.—The Niagara Falls and Clifton steel arch bridge was built in 1895-1898. It consists of a main span of 840 ft. and two end spans, one of 190 ft. and the other of 210 ft., giving a total length of 1,240 ft. The main arch springs from the solid rock. The arch is two-hinged, parabolic, and has a rise of 137 ft. The end spans are pin-connected, inverted bow string trusses. The bridge carries on one level two lines of trolley car tracks, two carriageways and two side walks, having a total width of 46 ft. There are 1,637 cu. yds. of masonry in the substructure. The materials used in the main span were as follows:

	Lbs.
Two-arch trusses, not including laterals	1,673,356
Laterals of arch	383,522
Bents, including lateral bracing	450,577
Longitudinal bracing	150,705
Skewbacks and shoes	226,634
Floor system	766,287

Total

In addition there were:	
New York end span	344,862
Canadian end span	371,733
Hand rail and floor fastenings	83,048
Miscellaneous (field rivets, etc.)	81,323

Grand total

There were 246,000 ft. B. M. of timber in the permanent flooring.

Weight and Cost of a 195 ft. Span Arch Bridge.—A steel arch highway bridge was built in 1900 across Nine-Mile Run, at Pittsburg. The total length is 444 ft. The carriageway is 36 ft. wide, on each side of which is 6½-ft. cantilever sidewalk, making a total width of 49 ft. of floor. It consists of a steel arch span, 195 ft. c. to c. of

pins, and a steel viaduct approach of five 24-ft. plate girder spans on each side of the arch span. The arch span is a pair of three-hinge plate girders. The sidewalks and carriageway are made of buckle plates and concrete, the carriageway being paved with asphalt. The arch has a rise of 59 ft.; and, as the ground rises rapidly from the skewbacks toward each end of the bridge, the average height of the viaduct approaches is about half this rise, or 30 ft.

The materials were as follows:

Structural steel (Lbs.)	1,457,000
Railing, 889 lin. ft. (Lbs.)	60,000
Stone Masonry (Cu. Yds.)	1,410
Concrete (Cu. Yds.)	287
Paving on roadway (Sq. Yds.)	1,800
Paving on sidewalk (Sq. Ft.)	5,500
Curb (Lin. Ft.)	890

The total contract cost was \$86,534, including \$535 for mill, shop and field inspection of the steel, or 70 cts. per ton for inspection.

This is equivalent to \$195 per lin. ft., or \$4 per sq. ft. of floor.

Weight of a 207 ft. Span Arch Bridge.—A single track, three-hinged steel arch bridge was finished in 1903 across the Menominee River, Michigan, for the Chicago, Milwaukee & St. Paul Ry., replacing a steel bridge built 17 years previously, which had grown too light for the traffic. The bridge is 355 ft. long, consisting of a three-hinged arch of 207 ft. span and four plate girder approach spans of 39½ ft. each. The trusses are 22 ft. c. to c. The arch has a rise of 52 ft. The bridge is designed according to Cooper's specifications for a live load of two consolidation Class E-50 locomotives and 7,000 lbs. per lin. ft. behind the engines. The weight of steel in the arch span is 480,000 lbs., and in the approach spans it is 150,000 lbs.

Weight and Cost of a 440 ft. Span Arch Bridge.—A steel highway bridge was built in 1906 in Pittsburg. It is known as the Oakland Bridge. It is 800 ft. long and has a roadway 20 ft. wide, with a 7 ft. cantilever sidewalk on each side. It consists of an arch having a span 440 ft. and a rise of 70 ft., and a steel viaduct approach at each end of the arch, the spans of the approach girders being 30 to 10 ft. each. The arch span consists of two lattice girder arch ribs, abutting on concrete abutments built on the solid rock. The arch is not hinged. The cost of this bridge was \$138,000, which is equivalent to \$172 per lin. ft., or \$4.50 per sq. ft. of floor area.

Cost of an Arch Bridge.—A steel highway bridge was built in 1906 across the Potomac River, at Washington, D. C. The

*Reprinted from the Canadian Engineer.

bridge is 1,000 ft. long between abutments, and consists of 6 three-hinged arch spans of 129 ft. each, and one two-leaf bascule span of 103 ft. Each of the arch spans has six plate girder ribs. The bridge is 48 ft. wide between handrails, having two 6½ ft. sidewalks and a 35 ft. roadway. The rise of the arches is 11 ft., and the height of the piers averages about 65 ft. to the spring line. The concrete piers rest on pile foundations. The site of each pier had to be dredged before driving the piles. The low water surface is about 10 ft. below the spring line of the arches. The bridge cost \$375,000, or \$375 per lin. ft., or \$7.80 per sq. ft.

Method of Sinking a Foundation for a Bridge Pier.

The following is abstracted from the discussion on a paper by H. L. Wiley on "The Sinking of the Piers for the Grand Trunk Pacific Bridge at Fort William, Ontario, Canada,"* that appears in Vol. xxxiv., page 1213, of the Proceedings of the American Society of Civil Engineers. Mr. C. R. Fickes gives the following description of deep foundation work for a bridge over Red River near Shreveport, La., for the St. Louis Southwestern Railway.

Seven piers and one abutment were founded by the open-caisson method. Four of these, including the pivot pier, were carried down to solid rock, while the others were built on piles driven under water by a long follower.

The method of founding the pivot pier may be of interest.

This pier was in the channel of the stream which had a velocity of about 4 miles per hour at ordinary stages of the water and 8 miles at high-water stages. There is a variation of about 40 ft. between extreme high and low-water stages, and the tropical rains of that region often bring on a rise of 20 ft. or more in 12 hours.

Borings previously taken at the site of this pier showed that the rock was about 90 ft. below the ordinary stage of the water and was overlaid by a stratum of stiff blue clay 20 ft. thick. Above this, up to the bed of the stream, the borings showed ultimate layers of clay, gravel and coarse sand for a thickness of 40 ft. This made about 65 ft. of soil to be penetrated by the caisson.

The coffer-dam was octagonal in shape, being 37 ft. on the short diameter. It was built of heavy timbers of yellow pine varying in size from 12x12 in. in the bottom courses to 8x12 in. at the top of the crib. These timbers were fastened together by ¾-in. drift-bolts, 4 ft. apart in each course, and the crib was braced inside by 6x12-in. sticks joining the centers of alternate sides of the octagon. These braces were from 4 to 6 ft. apart vertically and also served as supports for a cylindrical movable form to be described later.

The cutting edge of the caisson was

formed of ¾-in. plates, 30 in. wide, joined at corners with 4x4-in. angles and well riveted. The cutting edge was fastened to the bottom courses of the timbers with heavy iron straps and ¾-in. bolts.

All joints between timbers were carefully caulked with oakum before being lowered beneath the water.

Vertical sheeting of 2x12-in. surfaced planking was spiked on the outside of the crib to lessen the friction.

The caisson was built on a platform supported by piling driven circular around the site of the pier, and lowered to the bed of the stream by eight lowering screws 3 in. in diameter and 30 ft. long.

Inside this octagonal caisson, and concentric with it, was supported a cylindrical movable form 25 ft. in diameter, made of 2x6-in. by 12-ft. lagging, smooth on outside of cylinder and well braced inside. This left a space about 5 ft. wide between the form and inside of caisson, which was filled with concrete as the caisson was lowered. The form was raised as soon as the concrete hardened and was not allowed to become submerged in the water.

This wall of concrete gave the requisite strength to withstand the pressure when the crib was pumped out, and also the necessary weight to overcome friction in sinking.

This concrete shell was carried up 65 ft. from the cutting edge, so that the top of it would correspond with the bed of the stream, when the cutting edge had reached the rock.

When the caisson had been lowered to the bed of the stream, the material inside was removed by two 1-yd. orange-peel dredges operated by derricks and hoisting engines mounted on a large floating barge anchored beside the crib. Other barges carrying the concrete mixer and material were anchored on the opposite side of the crib, and the operations of building up the concrete and timber wall and of excavating and sinking the crib went on alternately.

It was found that the weight of the wall was sufficient to carry the crib down to the required depth and no additional loading was necessary.

Occasionally, when the excavation had been carried down 3 or 4 ft. below the cutting edge and the crib failed to follow, a small charge of about half a stick of dynamite, dropped into the hole and exploded, caused the crib to settle at once. Several logs were encountered by the cutting edge. These were broken up by dynamite placed by divers and exploded by an electric battery.

No trouble was had at any time from material running in from the outside under the cutting edge.

Only one mishap occurred during the construction of this pier, and that happened when the cutting edge lacked only a few feet of reaching the rock. The top of the concrete wall was then about 3 ft. above the bed of the stream, and above this was about 25 ft. of timber crib extending a few feet

above the water. A sudden rise in the river brought down several acres of drift-wood, carrying away four clusters of protection piles which had been driven up stream from the pier, and finally breaking off and carrying away that part of the crib above the concrete wall. All barges and floating equipment were torn loose from their anchorages and only recovered with much difficulty several miles down stream.

The problem now was to replace the lost part of the crib and attach it to that portion left intact under about 20 ft. of water. This was accomplished as follows:

A new crib of the same shape as the old, but 2 ft. less in diameter, was built and floated into position over the submerged portion, and, by means of weights, sunk so that its lower edge rested on the concrete wall just inside the old timber part of the crib. On the lower edge of this new crib was placed a pad of felt, 2 in. thick, for the purpose of partially caulking the joint. The new crib was securely fastened to the old one by ¾-in. straps and spikes driven by divers, who also completed the caulking of the joint.

When this was accomplished, the excavation of material from the inside of the crib was continued by the dredges, and the cutting edge was soon lowered to the rock.

Divers were then sent down inside the caisson, and the surface of the rock, which was found to be fairly level, was cleaned off as thoroughly as possible by water jets. A hydraulic sand pump was also used for removing the material stirred up by the jets.

A layer of 1:2:4 concrete, 4 ft. thick, was then deposited over the surface of the rock by bottom-dump buckets carefully lowered through the water. This concrete was placed without any interruption so that there would be no joint. Forty-eight hours was given for this concrete to harden, after which two 8-in. pulsometer pumps were lowered into the hole, and unwatered the caisson in a few hours. The bottom was found to be sealed effectually by the layer of concrete already described, and the shell of concrete was practically waterproof. Some little leakage occurred at the joint between the old and new parts of the crib, but this was soon overcome by caulking.

After this, the concreting proceeded rapidly in the dry, and the well was soon filled up to the point where the neat work was to begin. The forms were then erected and the pier carried to completion without mishap.

The average daily distance of sinking the caisson was about 4 ft., and the greatest distance sunk in ten consecutive hours was 8 ft. This is exclusive of time lost by reason of high water and replacing the crib as described.

The completed pier is 26 ft. in diameter above the water and contains approximately 3,000 cu. yd. of concrete. It is the support for a 300-ft. single-track railway swing span.

The cost of the completed foundation was

*See Engineering-Contracting Sept. 30, 1908, p. 205, for a reprint of this paper.

much less than the average cost of pneumatic work and has several advantages not possessed by the latter, among which is the fact that the continuity of the concrete is not broken by a deck of timber as in the case with pneumatic foundations.

No trouble was experienced in keeping the caisson in position during the sinking. By careful work with the dredges, the crib was kept practically level at all times. When finally landed, it was less than 2 in. off center in either direction.

The other caissons sunk by this method were rectangular, 40 by 22 ft., and had concrete walls inside the timber cribs, 4 ft. thick, with a cross-wall of concrete dividing the inside into two wells 12 ft. square, through which the earth was excavated as from the single well of the octagonal caisson.

No trouble was experienced with any of these caissons, as no sudden rise occurred in the river during their construction and sinking.

In the case of one pier erected on shore, the caisson was carried 85 ft. through the soil. Weight in addition to that of the concrete wall was necessary in this case and was secured by loading the crib with large boxes filled with earth removed by the dredges from the inside of the crib.

The completed bridge consists of four through spans of 200 ft. each, one of 150 ft., and a swing span of 300 ft. There are about 100 ft. of creosoted pile and steel trestle approaches at each end of the bridge.

J. W. Schaub, M. Am. Soc. C. E., was Consulting Engineer for the work, and prepared the plans. M. L. Lynch, Am. Soc. C. E., is Chief Engineer of the St. Louis Southwestern railway. The contract for foundations and steel erection was held by the Missouri Valley Bridge and Iron Co., the steel being fabricated by the Phoenix Co. Mr. Wiley had direct charge of the work as Resident Engineer from start to completion.

During the month of September the steam shovels at work on the Isthmian Canal excavated 1,714,995 cu. yds. of material, according to the Canal Record. A new record for excavation in one day was made on the last day of the month, when the 52 shovels at work in the Central Division took out 63,418 cu. yds., an average of 1,220 cu. yds. per shovel. The high record for the month was made by shovel 217, at work in the Culebra District, which took out 52,892 cu. yds. in 25 days, an average of 2,116 cu. yds. a day. The best record for a shovel in the 70-ton class was made by shovel 102, which excavated 36,842 cu. yds. of rock from the lock site at Gatun. Shovel 134, at work at the same place, took out 35,360 cu. yds. Shovel 209, at work in the Central Division at Pedro Miguel, made the highest record for one day by excavating 3,100 cu. yds. of soft rock on Sept. 28.

Railway Section

Note: This section is devoted to methods and costs of constructing railways. It will cover road-bed and track construction, contractor's plant and organization, surveying methods and permanent way structures.

The Detailed Cost of Laying Side Tracks and Switches Including Labor and Materials.

Practically nothing has ever been printed as to the cost of laying side tracks and spurs. We purpose giving in this article eight examples of the actual cost of this sort of work on a western railway.

The grading was done, in most cases, by contract and its cost is not included in the following costs, unless specifically mentioned. The tracklaying and surfacing were done by company forces.

Example 1. This is a spur track 400 ft. long.

Labor:	
8 days, foreman at \$1.50.....	\$12.00
16 days, laborers at \$1.25.....	20.00
Total labor, 400 ft. at \$0.08.....	\$32.00
Materials:	
158 cedar ties at \$0.35.....	\$ 55.30
1 set stub switch ties, 3,200 ft. B. M. at \$15.....	48.00
800 ft. S. H. (second hand), 56 lb. rail, 6 and 1886/2240 tons at \$16..	109.31
52 S. H. angle bars, 728 lbs. at \$1.37..	9.97
100 S. H. track bolts, 85 lbs., at \$1.95..	1.66
400 lbs. new spikes at \$1.85.....	7.40
1 frog (56 lb.).....	8.00
1 S. H. switch lock.....	0.25
2 S. H. 2 way switch chairs, 190 lbs., at \$1.65.....	3.14
6 connecting rods, 5' 2", at \$1.35....	8.10
1 S. H. long connecting rod.....	2.50
1 high switch stand, 2 way.....	8.00
Total materials	\$261.63
Grand total, 400 ft., at \$0.73.....	\$293.63

Example 2. This work involved putting in a switch to connect two tracks, the length of track laid being 118 ft.

Labor:	
4½ days, foreman at \$1.80.....	\$ 8.10
14½ days, laborer at \$1.25.....	18.13
4 days, laborer helping engineer stake out spur, \$1.25.....	5.00
Total labor, 118 ft. at \$0.265.....	\$31.23

Materials:	
19 S. H. switch ties at \$0.10.....	\$ 1.90
1 set switch ties, 2,677 ft. B. M. at \$14	37.48
108 ft. new 75 lb. rail, 1 460/2240 tons, \$27.....	32.51
127 ft. S. H. 75 lb. rail, 1 935/2240 tons, \$16	22.68
22 new 25 lb. angle bars, 528 lbs., \$1.45	7.66
62 track bolts, 52.7 lbs., \$2.00.....	1.05
256 track spikes, 143.4 lbs., \$1.68....	2.41

1 new 75 lb. 1-7 frog.....	16.65
1 new sw. lock.....	0.46
1 S. H. sw. stand, 2 way, low..	4.40
2 new switch points (75 lb.) at \$7.10	14.80
12 new tie plates at \$0.25.....	3.00
8 new rail braces at \$0.155.....	1.24
1 main rod.....	6.90
3 connecting rods at \$0.50.....	1.50
8 clips at \$0.27.....	2.16
24 clip bolts, 12 lbs., at \$3.10.....	0.37
1 S. H. short connecting rod.....	1.10

Total materials

Grand total, 118 ft., at \$1.55....\$183.55

Example 3. This work consisted in putting in a passing track 2,500 ft. long.

Labor tracklaying:	
20 days, foreman at \$1.80.....	\$ 36.00
78 days, laborer at \$1.35.....	105.30

Total labor, 2,500 ft. at \$0.056....\$141.30

Materials:	
2 S. H. head blocks, 224 ft. B. M., at \$6	\$ 1.34
1,245 S. H. ties at \$0.145.....	180.53
2 sets sw. ties, 34,045 ft. B. M., at \$20.00	68.09
42 planks (3 x 12-16), 2,016 ft. B. M., at \$11	22.17
4,969 ft. S. H. 56 lb. rail, 41 911/2240 tons, at \$16.....	662.51
340 S. H. A bars, 4,500 lbs., at \$0.88..	40.39
182 new trk. bolts, 155 lbs., at \$1.85..	2.86
592 S. H. trk. bolts, 503 lbs., at \$1.40..	7.04
5,100 spikes, 2,856 lbs., at \$1.65.....	47.12
2 frgs (1-9), 60 lb. at \$13.25.....	26.50
2 H. T. 2 way sw. stands at \$7.25....	14.50
2 long conn. rods at \$2.10.....	4.20
2 S. H. conn. rods at \$1.05.....	2.10
14 S. H. conn. rods at \$0.53.....	7.12
8 sw. stand bolts, 12 lbs., at \$2.25....	0.27
8 sw. nuts	0.33
10 sw. chairs (60 lb.), 357 lbs., at \$1.45	5.18
2 sw. locks at \$0.29.....	0.58
2 S. H. guard rails (60 lbs.) at \$1.27..	2.54

Total materials

1,720 cu. yds. grading at 13 cts....\$613.60

Labor ballasting:	
5½ days, foreman at \$1.80.....	\$ 9.90
11 days, laborer at \$1.35.....	14.85

Total labor ballasting.....\$24.75

Grand total, 2,500 ft., at \$0.75...\$1,875.32

Example 4. The work consisted in laying a passing track 2,500 ft. long, including grading, ballasting and surfacing.

Labor grading:	
15 days, foreman at \$1.80.....	\$ 27.00
10 days, laborer at \$1.25.....	22.48

195 days, team at \$3.50,...	682.50
Total grading	\$731.98
Labor laying track:	
4 days, foreman at \$1.80,.....	7.20
80 days, laborer at \$1.25,.....	100.00
Total, 2,500 ft. at \$0.043,.....	\$107.20
Labor moving a switch:	
1 day, foreman,.....	\$ 1.80
8½ days, laborer at \$1.25,.....	10.63
Total	\$12.43
Labor surfacing track:	
4 days, foreman at \$1.80,.....	\$ 7.20
20 days, laborer at \$1.25,.....	25.00
Total	\$32.20
Work train service ballasting:	
1.4 days, engine service (140 mi.) at \$27.50	\$38.50
1.5 days, conductor at \$80 mo.	4.44
3 days, brakeman at \$60 mo.	6.67
Total	\$49.61
Materials:	
4,760 lin. ft. S. H. 56 lb. rail, 39 1493/2240 tons, at \$16,.....	\$ 634.66
128 lin. ft. S. H. 50 lb. rail, 2133/2240 tons, at \$16,.....	15.24
1 new No. 9 frog,.....	13.25
1 new No. 1 frog (56 lb.),.....	12.25
4 guard rails at \$1.27,.....	5.08
1,088 ties at \$0.23,.....	250.24
2 sets sw. ties, 5,354 ft. B. M., \$12.00	64.25
4 H. B. bolts, 12 lbs., \$2.25,.....	0.27
318 S. H. 56 lb. A bars, 4,452 lbs., \$0.88	39.18
2 sw. stands, \$7.25,.....	14.50
12 S. H. 50 lb. splice bars, 108 lbs., \$0.88	0.95
8 sq. nuts, 2 lbs., \$2.90,.....	0.06
648 new track bolts, 551 lbs., \$1.85,.....	10.19
2 sw. locks, \$0.45,.....	0.90
4,990 new track spikes, 2,794 lbs., \$1.65	46.11
2 long conn. rods, \$2.10,.....	4.20
1 new 2 way sw. chairs, cast 382 lb., at \$1.15,.....	5.54
2 new tie rods, \$1.10,.....	2.20
10 new conn. sw. rods, \$1.10,.....	11.00
8 rail braces, \$0.91,.....	0.73
12 crossing plank (3 x 12—16), 576 ft. B. M., at \$10.00,.....	5.76
12 lbs. spikes, \$1.85,.....	0.22
2 sets frog blocking, \$1.20,.....	2.40
Total materials	\$1,139.18
Grand total, 2,500 ft. at \$0.829, \$2,072.60	

Example 5. This is an industry spur 550 ft. long, and the cost of labor only is given. The rail was 56 lb., and the cost of materials can be easily estimated from the examples previously given.

10 days, foreman, \$1.80,.....	\$ 18.00
30 days, laborer, \$1.50,.....	45.00
24 days, team and driver, \$4.00,.....	96.00
Total, 550 ft., at \$0.28,.....	\$159.00
Note the high cost due to team work.	

Example 6. This consisted in making an extension 180 ft. long to an existing spur, so that no switch was put in.

Labor:	
3.6 days, foreman at \$55 mo.	\$ 6.75
11.6 days, labor at \$1.50,.....	11.16
4.8 days, labor at \$1.20,.....	5.01
Total labor, 180 ft., at \$0.141,.....	\$25.95

Material:	
360 ft. S. H. 60 lb. rail, 3 180/2210 tons, \$21.20,.....	\$ 77.79
21 S. H. A bars, 312 lbs., \$1.53,.....	5.23
190 track spikes, 106 lbs., \$1.59,.....	1.69
48 S. H. tr. bolts, 41 lbs., \$2.01,.....	0.84
90 treated ties, \$0.36,.....	32.40
Total	\$117.95

Grand total, 180 ft., at \$0.80,....\$143.90

Example 7. This consisted in building an industrial spur 550 ft. long. The low cost of the labor should be noted, as compared with that in Example 5, where an inordinately high team cost appears.

Engineering:	
8 hrs., asst. engr. at \$100 mo.	\$2.58
8 hrs., rodman at \$50 mo.	1.29
8 hrs. chainman at \$40 mo.	1.03
Total engineering	\$4.90

Labor:	
55 hrs. foreman at \$55 mo.	\$ 9.75
475 hrs. laborer at \$1.25 day	59.20
Total labor, 550 ft., at \$0.126,.....	\$68.95

Material:	
1,052 ft. S. H. 56 lb. rail, 19,637 lbs., at \$21.20	\$212.10
30 ft. scrap rail (56 lb.), 560 lbs., at \$7.37	1.84
76 A bars (56 lb.), 1,083 lbs., at \$2.25,.....	27.62
129 lbs. tr. bolts at \$3.19,.....	4.12
700 lbs. tr. spikes at \$2.98,.....	18.06
1 rigid frog (1-9), 60 lb.,.....	21.05
1 sw. stand,.....	6.68
4 sw. bolts,.....	0.20
1 long conn. rod,.....	2.33
1 split sw. compl. (60 lb.),.....	23.52
2 guard rails, 10 ft., 50 lb.,.....	6.56
12 S. H. rail braces, 8½ ct.,.....	1.02
1 sw. lock,.....	0.38
1 set sw. ties, 3,283 ft. B. M., at \$8.50,.....	27.91
1 sand bumper,.....	9.20
Total materials	\$362.59

Grand total

It will be noted that no charge for cross ties (other than the set of sawed switch ties) is made. Hence the cost of materials is incomplete.

Example 8. This is a crossover track, 496 ft. long.

Engineering:	
1 day, asst. engr.	\$2.75
1 day, rodman	1.60
1 day, chainman,.....	1.30
Engr. expense	4.35
Total	\$10.00

Labor:	
Putting in sw. ties and grading new crossover track:	
1.5 day foreman at \$75 mo.	\$ 3.75
1.5 day timekeeper at \$60,.....	3.00
1.5 day asst. foreman at \$60,.....	3.00
38 day laborers at \$1.75,.....	67.35
Total	\$77.10

Putting in crossover track:	
1 day foreman at \$75,.....	\$ 2.42
1 day timekeeper at \$60,.....	1.93
1 day asst. foreman at \$60,.....	1.94
39.8 day laborers at \$1.75,.....	69.65
Total	\$75.91

Surfacing crossover track:	
0.4 day foreman at \$75,.....	\$ 0.97
0.4 day asst. foreman at \$60,.....	0.97
0.5 day timekeeper at \$60,.....	0.96
11.5 day laborers at \$1.75,.....	20.10
Total	\$22.80

Materials:	
50 ft. 80 lb. 1st. qual. rail, 1,333 lbs., at \$29.30	\$ 17.43
87 ft 80 lb. 2d qual. rail, 1 80/2240 tons, at \$29.30,.....	28.89
679 ft. S. H. 68 lb. rail, 6 1951/2240 tons, at \$24.20,.....	166.27
41 S. H. ties at \$0.10,.....	4.10
130 treated ties at \$0.37,.....	48.10
1 set sw. ties,.....	27.81
1 set sw. ties,.....	22.51
14 new 24 in., 80 lb. A bars, 290 lbs., \$1.30	3.77
2 new W. joints, \$0.96,.....	1.92
50 S. H. 36 in. 68 lb. A bars, 1,200 lbs., \$0.98,.....	11.76
4 new 24 in. offsets, 68 lbs., \$1.37,....	0.93
185 new tr. bolts, 157 lbs., \$2.48,.....	3.89
1,331 new spikes, 745 lbs., \$1.88,.....	13.97
1 new No. 9 sprg. rail frog (77½ lb.)	35.50
1 new No. 7 frog (68 lb.)	13.70
1 S. H. sw. stand,.....	2.98
1 new sw. stand,.....	5.55
8 sw. stand bolts, 14 lbs., \$3.66,.....	0.51
1 sprg. switch comp., 15 pts. (68 lb.),.....	18.11
1 sprg. switch comp., 15 pt. (68 lb.),.....	9.41
1 S. H. long conn. rod,.....	0.70
1 short conn. rod,.....	0.34
2 guard rails comp. (80 lb.),.....	13.65
2 S. H. 68 lb. guard rails, 680 lbs., \$13.80	4.19
2 sw. locks repd., \$0.18,.....	0.36
2 sets frog blocking, \$0.15,.....	0.30
1 sw. lamp,.....	1.85
68 new tie plates, 273 lbs., \$2.15,.....	5.87
115 S. H. tie plates, 1,177 lbs., \$1.875,.....	22.07
9 S. H. wall rail braces, 22 lbs., 11.05 cts.,.....	0.12
Total material	\$486.56
Grand total, 496 ft., at \$1.366,....	\$672.40

The high cost of the labor is attributed to "extra labor expended in clearing and to considerable interference by switch engine, this work being done in the yards."

Summary. On short side tracks or crossovers the cost of putting in a switch con-

stitutes a much larger percentage of the total cost than on long side tracks. Hence the cost of labor, as well as of materials, is greater per lineal foot of short side track than of long side track.

In a subsequent issue we shall give a large number of additional examples of the cost of such work as this, and we shall then be able to summarize the results and indicate methods by which accurate estimates of cost can be made.

Life of Manganese Steel Rail on Curves —From Service Tests made on the Boston Elevated Railway.*

BY H. M. STEWARD.†

Within a few months after the elevated division of the Boston Elevated Railway Co. was opened for traffic (June, 1901) it was found that the rails on the curves were wearing out at an unprecedented rate. As about 40 per cent of the entire length of the line is curved, the question of maintenance and the cost of rail renewals became, and still is, a serious problem.

The tracks on the elevated division were first laid with Bessemer rail having a low carbon element (about 0.45 per cent) and the life of the outer rail on the sharp curves was very short, averaging about 60 days. On account of this excessive rail wear, the railway company determined to make a trial of manganese steel rail, and a curve in the subway near Park St. station, having a center radius of 82 ft., was selected for the trial. In 1902 the outer rail of the curve was relaid with manganese rail. These rails were cast in 20-ft. lengths, conforming as nearly as possible to the Am. Soc. C. E. 85-lb. section, and were purchased of William Wharton, Jr., & Co., Inc. The Bessemer rail which was in the track immediately preceding the installation of the manganese rail wore down 0.065 ft. in 44 days, as shown in Fig. 1. The manganese rail remained in service up to August, 1908, when it was removed on account of an accident. It will, however, be replaced in the track within a short time and will be allowed to wear out completely. Fig. 2 shows the result of this experiment after the manganese rail had been in service 6 years, 3 months and 7 days, or 2,291 days. The amount worn from the top to the rail, only 0.046 ft., is certainly remarkable and illustrates the great resistance this metal offers to rolling friction. The comparative wear of ordinary as against manganese steel for a period of 2,291 days is graphically shown in Fig. 3.

The traffic over this piece of track in 1902 was, of course, much less than at present, averaging probably 1,000 cars, or 36,000 tons, per day, as against 1,700 cars, or 62,000 tons per day, as present. Consequently the manganese rail, on account of the con-

stant increase in traffic, has given even better service than the comparative results show. Other instances could be cited, but in these cases the manganese rail has not been in service such a long period of time, al-

tangent rail does not, of course, receive such hard usage as that on steam roads, and the joints do not suffer from the pounding of heavy locomotives. Manganese steel, while offering great resistance to grinding fric-

COMPARATIVE LIFE OF SEVERAL KINDS OF STEEL RAILS ON TYPICAL SHARP CURVES. SPEED OF TRAINS FROM 8 TO 10 M.P.H.

Location of curve.	Radius.	Ordinary Bessemer Rail.		High carbon Bessemer Rail.		Nickel Rail.		Manganese Rail.		Open Hearth Rail.	
		Mo.	Ds.	Mo.	Ds.	Mo.	Ds.	Mo.	Ds.	Mo.	Ds.
Park St., S. B. (subway)...	82 ft.	2	3	8	18†	3	12†	76	4*	1	11
Adams Sq., N. B. (subway)...	89 ft.	2	17	10	15	4	4†	80	10†	1	27
Park St., S. B. (subway)...	90 ft.	2	16	10	11†	4	3†	66	15*	1	20†
Haverhill St., N. B.	100 ft.	4	3	11	13	6	19	128	9†	2	21
Sullivan Sq., loop	106 ft.	3	7	13	8	5	7†	101	5†	2	7

*Still in service. †Estimated life from actual results on curves of similar radii.

though the comparative results are equally as good. This one example, however, is probably sufficient to illustrate the long life and value of rails made from this metal.

In 1902 and 1903 the railway company purchased about 700 ft. of manganese rail at an average cost of \$5 per lin. ft. The cost of Bessemer rail, to this company, averages about 0.39 cts. per lin. ft.

From time to time we have made other experiments with special rolling of Bessemer, nickel and open-hearth rails. In 1903 the Cambria Steel Co. furnished us with some Bessemer rail having a carbon element of about 0.78, the wearing qualities of which were very satisfactory when compared with ordinary Bessemer rail and were far better

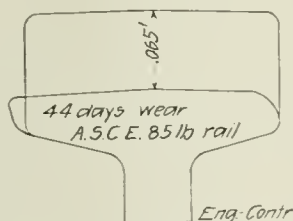


Fig. 1—Section of Commercial Rail, Showing Wear.

than the nickel and open-hearth rail which we have obtained up to the present time. None of these rails, however, approached the manganese rail in length of life.

As it is of interest to compare the life of different brands of rails under the same conditions, I have selected five curves of short radii and have prepared a tabulation showing the comparative life of five different kinds of rail.

We have not been able actually to test all of these rails on each of the curves, but from the actual results obtained on curves of similar radii we are able closely to estimate the life of the rails. In the preceding table these comparisons will be found.

The general use of manganese steel on tangents does not seem to me to be advisable. Even under the severe traffic of the elevated ordinary rail has given fairly satisfactory service for over seven years. Our

tion, will not, in my opinion, offer as great resistance to heavy blows on account of its ductility. Under heavy locomotive service I should say that the joints would batter and bend down some time before the rail would otherwise wear out. Its high cost also prohibits its use for this purpose.

In our service we find that manganese rail

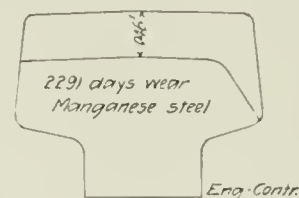


Fig. 2—Section of Manganese Steel Rail, Showing Wear.

will not withstand side wear equally as well as top wear. The grinding friction from the flat of the tire does not seem to have the same effect on manganese steel as the cutting action of the flanges, and we have found it advisable to protect the side of the head of manganese rail, holding the flanges away from it by means of a check or guard rail fastened securely to the inner rail of the curve. As the guard rail can be readily

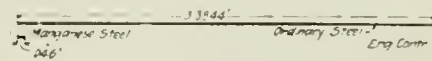


Fig. 3—Comparative Wear of Ordinary and Manganese Steel for 2,291 Days.

lubricated, it does not wear out particularly fast and we can afford to allow it take the side wear and in this way protect the manganese rail.

On account of the excellent results obtained from manganese steel, the railway company purchased during the last two or three years 4,700 lin. ft. of this rail at an average cost of \$6.70 per ft.

All the manganese rail used by the company up to the present time has been cast in lengths not exceeding 20 ft. On account of its having been necessary to cast the rail, the cost has been exceedingly high, due not

*Read before the American Street & Interurban Railway Engineering Association, Atlantic City, N. J., Oct. 12, 13, 14, 15 and 16, 1908.

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so much to the cost of the metal as to the labor involved in making the patterns, casting, and especially in finishing the rails. As it is not possible to machine the metal, the only way it can be finished to form is by grinding.

Recently the question of rolling manganese rail has been taken up by two companies in this country, and at least one in England. It is proposed to roll manganese rail in lengths up to 33 ft. and of any section desired. The Boston Elevated Railway Co. has not as yet obtained and made a trial of rolled manganese, but is about to do so, and has already placed orders for a limited quantity. When the rolled manganese rail is received the company proposes to make a comparative test with cast manganese rail of the same quality as was used on the Park St. curve. If the rolling of manganese rail is found to be successful and the metal is equally as good as when cast, the cost ought to be very much less than at present and the use of the material for track purposes should increase.

We have also used manganese steel extensively in frogs, switch points, etc. The difference in life, between manganese steel and rolled rail frogs and switch points, is great enough to warrant its use and will more than pay for the difference in first cost alone, while if the cost of maintenance is taken into consideration manganese steel is the cheapest metal that can be used.

As to the comparative cost of maintenance, the general maintenance of track, outside of rail renewals, should not vary appreciably whether the track be laid with manganese rail or Bessemer rail. Taking the curve at Park St. as a basis, and assuming that the life of manganese rail at this point would be eight years and that of Bessemer rail about two months, I should say that the following figures would be a fair estimate of the comparative cost of maintenance per linear foot of single rail for a period of eight years:

Cost of manganese rail per foot.....	\$6.70
Bonds, spikes, etc.....	.09
Labor	.22

Total cost of maintenance.....\$7.01

Cost of Bessemer rail per foot (50 renewals)	\$19.50
Spikes, bonds, etc.....	3.25
Renewal of ties, account "spike killing"	2.90
Labor	15.50

Total\$41.50

This comparison, you will understand, is made from one specific case in which the costs can be very closely estimated. The same proportions might or might not apply in other instances.

The results we have obtained from the use of manganese rail on the elevated division have been very satisfactory, and our experience would seem to show that railways operating under similar conditions should make liberal use of this material.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods and Cost of Constructing a Farm Drainage System.*

(Continued from page 265, Oct. 21 issue.)

Trenching by Hand.—In trenching by hand a line is stretched 10 in. to the left of the stake line in the direction in which the stakes are numbered. This line marks the right edge of the trench. The width of the trench at the surface varies with the depth of the ditch, being just wide enough for the workman to stand in and spade. The tools used are a skeleton or muck spade for removing the earth. This spade has a blade 18 in. in length, made of three prongs with a solid cutting edge at the lower end. A cut the full length of the blade is taken, the slice of earth cut being comparatively thin. The top of the spade is pushed slightly forward to break the cut loose, it is then raised and the material thrown out. The loose dirt which falls in the trench, known as crumbs, is thrown out by a long-handled, round-pointed shovel. The last cut of the spade reaches to within 2 or 3 in. of the grade line and is just wide enough at the bottom to admit the tile. The bottom is cleaned out and dressed to fit the lower half of the tile with the tile scoop. The tile scoop is a long-handled tool, semi-circular in shape, 16 in. in length and made in sizes to fit the various tile up to 8 in. Above that size the finishing is usually done with the long-handled shovel. The tile scoop is operated by standing in the trench and drawing toward the workman. The bottom of the trench behind this tool is smooth and conforms to the lower half of the tile. In trenching by hand, unless the trench is deep, or the digging hard, two men work together. One takes out the top spading, the other the bottom and finishes the trench. On deep trenches there is usually a man at work on each spading in depth, the trench being carried along in steps. Many tile ditchers throw the excavated earth on both sides of the trench, while others prefer to throw it all on one side; however, this is a matter of little importance in most localities.

The cost per rod or 100 ft. includes the excavation, tile laying and trenching. In this work 11,430 ft. of tile trenching must be done by hand. The contractor must let at so much per 100 ft. for the individual trenches, but the prices agreed with the common rule of tile construction, i. e., a fixed price for all trenches averaging 3 ft. or under in depth plus an additional sum for each inch additional average

depth over 3 ft. The average is found by dividing the sum of the cuts at all the stakes by the total number of stakes. In this case the price was 40 cts. for 3-ft. work, then 1 ct. for each additional inch up to 4-ft. work, then 2 cts. per inch for each additional inch. This gives prices for various depths as follows:

3-ft. trenching, 40 cts. per rod or \$2.42 per 100 ft.

3.5-ft. trenching, 46 cts. per rod or \$2.79 per 100 ft.

4-ft. trenching, 52 cts. per rod or \$3.15 per 100 ft.

4.5-ft. trenching, 64 cts. per rod or \$3.88 per 100 ft.

5-ft. trenching, 76 cts. per rod or \$4.60 per 100 ft.

The average work done by one man per day was 100 ft. of 3-ft. trench; 95 ft. of 3½-ft. trench, and 80 ft. of 5-ft. trench. Unskilled labor cost the contractor \$2. per day.

Trenching by Machine.—A Buckeye Traction Ditcher, which cut a trench 4½-ft. deep and 14½ in. wide, had been sent to the farm in 1903 for demonstration purposes, and was used throughout the season. This machine consists of a four-wheel truck, 4 ft. wide and 12 ft. long. The distance between the wheel centers was 6 ft. 4 ins., and 7 ft. between front and rear axle. The rear axle serves as a drive shaft and is geared to the engine shaft by chain belting. On the front end of the truck is placed an 8-H. P. vertical boiler, and immediately back of the boiler is a 6-H. P. single engine. Attached to the rear of the truck is a frame carrying the cutting wheel. This frame is connected to the truck by a cross bar, which is free to move up and down in the slots of two upright posts. The front part of the frame can thus be raised or lowered at will by means of a ratchet wheel. The rear of the frame rests on an oval metal shoe 4 ft. in length and 6 in. in width. This shoe runs to the bottom of the trench and shapes the bed for the tile. The cutting wheel, which is 8 ft. in diameter, and 12½ in. in width, is supported in the frame on movable pulleys at four different points on its inner rim, and is driven by cog gearing on this rim directly above the point of cutting. On the outer rim of the wheel are 14 cups having detachable knives on the outer edge, and one on either side, the side knives being curved outward to cut the trench wider than the main part of the wheel, to prevent binding. As the wheel revolves, the earth is excavated in thin slices and carried up by the cups to the top of the wheel where it is deposited on a short belt elevator and

*Abstract of a Report on the Installation of an Experimental Drainage System at the Northwest Experiment Farm, University of Minnesota, Crookston, Minn. Bulletin No. 110.

carried to the left side of the trench. A light iron fender controls the distance at which the earth is deposited from the ditch.

If it is desired to move the machine from one trench to another, the cutting wheel is raised until it clears the surface of the ground, when the entire machine can be moved in the same manner as a traction engine. When working on a trench the machine moves continuously forward under its own steam, thus causing the cutting wheel to feed. By shifting the sprocket wheels, the cutting speed can be varied. The depth of the cut is regulated by sighting over a cross arm on the side of the cutting frame, and a series of targets which have been set up ahead at the grade stakes, the cutting wheel being raised or lowered as desired by the operator. The direction is held by lining the center of the front and rear wheels with the upright of the targets. With care, a true line and grade can be carried, but where the ground is slightly uneven, constant attention is required. In setting the targets, the upright should be set so that the line of stakes will come midway between the side of the trench and the drive wheel on the right side. In this way the stakes will not be destroyed. If desired, the work could be staked out so as to allow the center of the trench to be 42 in. to the left of the stake line, when the wheels will run between the trench and stakes. Under the truck of the machine is 1-bbl. water tank, and in front of the boiler is a box that will hold 100 lbs. of coal. This is all the fuel that can be carried by the machine; other supplies must be distributed along the work.

The natural conditions on the farm were favorable for machine work, as the surface was uniformly level and the soil was free from stones, roots and sloughs; the only unfavorable conditions being the stickiness of the soil, and the fact that nearly all the trenches were made in grass land. Work was begun with the machine on Aug. 10, and completed on Nov. 9, covering a period of 85 working days, in which 33,498 ft. of trench were excavated. During this time there were 22 days when the machine was not run as other work required the attention of the men; hence, the actual time during which the machine could be run was 63 days. Out of this period, the machine could not be operated for 18 days as it was awaiting repairs. The total time which the machine was actually operated being 45 days, excavating an average of 744 ft. of trench per day. It was necessary to run the machine at the lowest cutting speed which would excavate 100 ft. of trench in 32 minutes, but unavoidable delays cut down the daily run. An ordinary day's work varied from 600 to 1,000 ft., averaging approximately 800 ft. Delays were occasioned from a variety of causes. In crossing dead furrows or low strips of land which were wet, the

drive wheels would slip and the machine would not move ahead. This required a considerable loss of time, as it was necessary to bring up short pieces of plank and work them under the wheels in order to carry the weight of the machine. This frequently occurred at points where the surface was apparently dry and trouble was not suspected until the wheels began slipping. Strips of timber 2x4x30 ins. long were bolted to the drive wheels to increase the bearing surface, but these quickly broke off when the machine was running on dry ground. In working through wet soil, the cups occasionally clogged, which would require the machine to stop until they were cleared with a spade. The wet earth collected on the rollers which operated the elevator, necessitating their cleaning. Another serious difficulty was the collection of grass roots on the knives, which would prevent the cutting of the soil and stall the machine. Whenever this occurred the machine had to be stopped and all the knives cleaned. Although the knives were sharpened, these grass roots interfered so much in the unbroken sod that stops had to be made every 30 or 40 ft. for the purpose of cleaning. Finally a breaking plow was used and two furrows were turned on the line of the trench. This was a partial remedy, but it caused the trench to be crooked. The loose sod would occasionally catch in the wheel and the plow would not go deep enough to remove all the roots. Another difficulty, which did not interfere with the operation of the machine, but delayed the tile-laying where the soil was wet, was that the bottom of the trench would not slip under the shoe but continually rolled. This required extra labor to dress with a tile scoop before the tile could be laid, and rendered it somewhat difficult to get a good grade as the bottom of the trench was unevenly torn up. This rolling up under the shoe appeared identical with the rolling of the clay in a tile machine where washed clay is used for making tile. The clay seemed to be of such fine material that when moist and pushed over a metallic surface it would stick to the metal rather than slip by.

On level land one man can operate the machine for a short period, but it is necessary to have two, the greater part of the time, one to tend the boiler and engine, the other to operate the ratchet wheels, which control the line and grade. The time to get the machine ready to start in the morning is from 45 to 60 minutes, and after dinner, from 30 to 40 minutes. On completion of a line, it required from 6 to 10 minutes to get the machine ready to move. On the arrival at the beginning of a new line 15 to 30 minutes was required to get in position and begin digging.

The traction speed of the engine when not digging is one mile per hour, but it is necessary to make stops to take coal and water; in turning to throw one of

the drive wheels out of gear, or to fill dead furrows. Three-quarters of a mile per hour is as rapidly as the machine can be moved. The water and coal carried by the machine will run it from three-quarters to one mile while moving, according to the condition of the ground. On a good road the machine could make a mile an hour and carry sufficient supplies to run that distance.

The coal used was the best quality of Pennsylvania soft nut coal, and cost \$7.50 per ton delivered at the farm. The amount required to cut 100 ft. of trench varied from 50 to 80 lbs. This variation was caused by the skill of the fireman, the ease with which the soil was cut, the number of stops which had to be made, and the general temperature. It was found that more coal was required in November when the winds were cold and frosty, than in August. The average amount of coal for the entire work was 60 lbs. per 100 ft. The coal was delivered near the farm well, where it was filled into sacks of approximately 100 lbs. each. These sacks were thrown on the water tank and hauled out with the water and distributed along the line of trench where needed. This cost of distributing the coal is included in the table of costs under the head of water.

Water was delivered to the machine by a 9-bbl. water tank, the tank being filled by the windmill, which required no attention except to turn the water into the tank and shut it off again when the tank became full. The tank was then hauled to the trench line and placed in barrels, which were distributed as such points as needed. About one-half barrel of water per 100 ft. of trench was required.

The repairs were not so expensive in themselves, as the time which they caused the machine to stand idle. The breaks which occurred required an enforced idleness of the machine from one to three days at a time. Any breaks which could be repaired by the crew were not counted in the time for repairs, but were considered in the day's work for the machine, and tended to decrease the average cut per day. The link chains broke frequently and the elevator wore rapidly, and nearly all the smaller sprocket wheels broke. The elevator and chains were repaired on the line by the crew, but the sprocket wheels required recasting, which usually took one to three days, although there are foundries in Crookston where castings are made every other day. Several of these wheels broke the second time. The knives were sharpened by being hammered out at a machine shop, there being 14 large knives and 28 side knives. The cost of sharpening was 20 cts. each for the larger and 10 cts. each for the smaller. As there was no gravel in the ground, the knives were not difficult to keep in condition, and the one sharpening was sufficient for the entire work.

Some incidental expenses are also con-

nected with the machine work. The machine could not turn on a radius of less than 300 ft., hence where one tile line emptied into another, hand digging was required to make the connection as the machine would start on the line of the trench. When the outlet was an open ditch it was necessary to scrape way the spoil bank the width of the machine, and sometimes hand digging was required as the machine could not be backed near enough to the open ditch to start the trench at grade. Where deep ditches or road was crossed it also required scraper work. A spade was secured by the machine's crew and when deep down furrows were encountered a few shovelfuls of earth in which the machine could run were thrown in by the fireman. This rendered the holding of the cutting wheel to grade much easier. The following statements give the cost of trenching, tile laying and blinding per 100 ft.:

Example 1.—A total of 8,750 ft. was completed in 13 working days. In this time the machine was laid up three days for repairs, the actual time worked being ten days. The average cut was 875 ft. per day. This work represents average conditions, and is considered as a fair example of what the machine can do in this soil, and the various items of expense were carefully kept.

	Cost per 100 ft.
Labor of running machine.....	\$0.457
Coal	0.188
Water	0.126
Oil	0.012
Repairs	0.112
Laying Tile	0.183
Blinding	0.048
Incidentals	0.092
Total	\$1.218

Example 2.—The conditions were more favorable. The soil being dry, the sod very thin, and the work closer to the building, less time was required by the men in going back and forth. As there were 400 ft. at the outlet ends of two ditches which exceeded 4.5 ft. in depth, these two sections were dug by hand. On five ditches there were from 100 to 200 feet on the outlet ends which exceeded 4.5 ft. in depth. The trench was excavated to the maximum depth of the machine over these sections, and the bottom then dug to grade by hand. This extra cost of digging is not shown in the following table, but is added to the cost of the machine work for the entire trench, as shown in the table of tile records. The total length of trench included in this table is 10,150 ft.

	Cost per 100 ft.
Labor of running machine.....	\$0.409
Coal	0.190
Water	0.087
Oil	0.010
Repairs	0.100

Laying Tile	0.212
Blinding	0.053
Incidentals	0.015
Total	\$1.076

Example 3.—On 14,298 ft. in all, the soil was wet and covered with a broken sod, two ditches being a wild sod which had never been broken.

	Cost per 100 ft.
Labor of running machine.....	\$0.516
Coal	0.263
Water	0.126
Oil	0.014
Repairs	0.200
Laying tile	0.235
Blinding	0.062
Incidentals	0.012
Total	\$1.428

The average cost of trenching, tile-laying and blinding for all the machine work done was \$1.25 per 100 ft.

The machine did not work as rapidly as was expected, and there were more delays from breaks than looked for. However, the soil is difficult to work, being much slower to handle by either spade or scraper than in many localities where tile work is done, and many of the delays were due to the nature of the soil, although the work was performed at the favorable season of the year. The best condition for machine work would be in dry ground which is in cultivation, the drier and harder the soil, the speedier can the trenching be done.

The machines which have been made during the past season have a number of improvements over the one used. It is believed that many of the difficulties with this machine would not be experienced in one of the later models.

On account of the scarcity and high price of labor, the tiling system could not have been completed this season if the machine had not been used, and the cost of work done would have been much greater. The machine and all the work in connection with it was done entirely by farm help. The foreman operated the machine the greater part of the time. When the machine was laid up for repairs, the help was used on other farm work, the rules for a day's work on the farm being that the men should leave the barn at 7 and 1 o'clock and arrive at the barn at 12 and 6 o'clock. In the foregoing tables of cost per 100 ft., no allowance was made for the first cost of machine. This machine, if bought new, would cost \$1,400. As it was a machine which had been used by the factory for demonstration purposes, it was considered as a second-hand machine and was secured by the state at much less than the original cost. As there is no means of determining the life of the machine, an estimate of the depreciation of machinery or interest on the investment is not considered in the cost of the work.

[It will be noted that on a trench 4½ ft. deep, hand labor, cost \$3.88 per 100 lin. ft., as compared with \$1.25 where the trench machine was used. This is an excellent showing for the machine, yet it is correctly stated that improvements have been made upon the machine which enable it to give even better service.

It is stated that constant attention is required, where the ground is uneven, if the trench is to be cut by the machine to true line and grade. This holds of all machine work of this character, but it simply means that the operator must not go to sleep on the job. He is provided with sight poles and targets, and can readily keep to line and grade if he will but pay attention to his work.

We note that the operator of this particular machine took 10 mins. to get the machine ready for moving from one ditch to the next. This indicates lack of skill or laziness on the part of the operator, for we have seen operators get ready for the move and actually make the move and commence cutting in 5 mins.

We also note that the operator took 45 to 60 mins. each morning firing up, and 30 to 40 mins. after dinner, all of which is lost time that should not have been lost. An operator of a machine should have it fired up before the starting hour in the morning. He should also eat his lunch at the machine and keep it fired up. This is the common practice not only on trench machines but on steam shovels, etc.—Editors.]

Tile Laying.—The laying of the tile should begin at the outlet and be continuous up stream. For convenience, the tile should be distributed close to the trench so that they can be reached by the layer without loss of time. In laying, the tile should be turned till they fit tightly on top, the open space being left on the under side. This fit is usually best obtained in crooked tile when the bowed side of the tile is turned up. Where a crack of over ¼ in. in width is left, it should be neatly covered by a piece of broken tile. At curves, the ends of the tile should be cut or laid tight on one side and open at the other and the opening battled with broken tile.

Tile up to and including 6 in. in diameter are usually laid by a tile hook, the workman standing on the bank of the trench. The tile is picked up with the hook, lowered into the trench and turned on the hook until it will fit when it is laid in position. A sharp rap with the hook on the end of the tile after it is laid often causes it to fit the preceding tile more snugly. Tile hooks are not carried in stock by dealers, but they can be readily made by a blacksmith. The hook is made of ½-in. round iron, the long part being 9 ins. and the short part 4 in. in length. The bend is of sufficient width to admit the wall of the tile without binding. The handle is an ordinary rake handle.

Small sizes of tile are sometimes laid by

hand, the workman standing on the tile already laid. In shallow trenches with a hard bottom this method is satisfactory, but in deep trenches it is difficult to reach down to the grade line, and in a soft bottom there is danger of displacing the tile by the weight of the workman. In trenches where the depth is so great that it is difficult to throw the earth out or where the trench is caving, the workman who finishes the bottom lays each piece of tile as rapidly as the bottom is prepared and throws the last spading of earth back on to it. The tile layer should not stand on the finished bottom while laying. In the larger sizes of tile where it is necessary to work backward in the trench and lay the tile, the finishing work should be done at the same time, each piece being put in place as rapidly as bed is prepared for it.

In laying tile in a machine trench, the trench being wide at the bottom, does not fit the tile so snugly as a hand trench. Consequently, care must be taken in laying not to disturb the tiles already in place. As the bed for the tile in such a trench is made by a heavy weight resting on a shoe, the bottom is much more solid than in a hand trench. The workman, when the tile hook is not used, can stand astride of the tile bed and lay without causing the same injury that would occur in a hand trench. The tile laying should follow closely after the machine for the reason that small crumbs rapidly fall into the trench and harden as they dry out. As a result, good laying cannot be done unless extra time is taken for cleaning. A hook made of strap iron 1 in. in width brought to an edge on one side is an advantage, as lumps of dirt which frequently fall into a machine trench can be better shoved to one side than with a hook of round iron.

Tile when laid in the trench should have even joints, with no sharp bends and present the general appearance of a continuous pipe. The tile layer should carefully inspect the tile as he proceeds with his work and reject all which are cracked, soft, or so ill-shaped that good joints cannot be made. Defects can usually be noticed when the tile is picked up with a hook.

After men have acquired some experience, 1 to 6-in. tile can be laid at a rate of 200 ft. per hour where the trench is in good condition and the tile convenient. On machine trenches where the tile layer threw in his own tile and did the necessary cleaning of the trench, as was usually the case, he made 100 ft. per hour.

Blinding.—After the tile are laid, a covering of 4 to 6 ins. of earth is put on to hold the tile in place. This covering is called blinding and is done by the workman walking astride of the trench, cutting down the earth below the surface from either side with a tile spade, care being taken that the tile or battled joints are not disturbed. File blinding can be done at a rate of 400 ft. per hour.

(To be concluded.)

LETTERS TO THE EDITORS.

The Hardening Process and Durability of Portland Cement.

Sirs: The present agitation regarding the durability of structures depending upon the bonding power of Portland cement brings out forcibly the fact that our knowledge of this material is comparatively meager. The articles appearing recently in your journal relative to fine grinding of Portland cement are very interesting as they open questions not only relative to the commercial value of cement, but also may shed some light on the life or durability of the bonding power of cement. It is generally accepted that by fine grinding the sand carrying capacity of cement is increased and the time required for setting is decreased. The tabulated results of these grinding experiments show that although the "market" cement sets much more slowly and showed a much lower tensile strength at the end of the short time tests, yet when given time, the tensile strengths of both approached each other, a result one might expect from the fact that the finer particles react with water much more rapidly than the coarser ones.

One may also infer from these tests that the initial set of cement is caused by the rapid setting of the finest portions of "market" cement, but as these are greatly in the minority, some time elapses before the bulk of the active material responds to the action of the water and begins to harden, thus causing the final set. However, since it is estimated that but 30 per cent to 40 per cent of ordinary cement possesses cementing properties, there is a large amount of material present of the correct composition to react with water, but unable to do so because of the size of grain. It is not size of grain alone that determines whether or no a particle of cement would harden, but the element of time must be considered, so when a cement is exposed to proper conditions of moisture for an extended time it is found that it gradually gets stronger and harder, due no doubt to the fact that the larger grains which normally were not susceptible to the action of water have slowly yielded, and may cause an increase in the bonding power, although a decrease may also occur.

It is broadly heralded by the anti-concrete people that cement is a short lived article, and all structures dependent upon its bonding force will ultimately fail, especially if exposed to the action of percolating water. Their conclusions seem to be based upon some recent experiments made by a few clay tile men who subjected specimens of concrete to the dissolving action of water, securing results which proved to them that about 10 per cent of the bonding material, Portland cement, per year went into solution, and therefore any concrete exposed to water could not last more than ten years. This

being the case, it became their self-imposed duty to travel throughout the country advising all to refrain from the use of this nefarious material in all structures and especially in drain tile as in less than ten years nothing but a streak of gravel would mark the location of former cement tile drains. However, fortunately for cement tile, experiments are not always infallible, so cement drains still exist in this section of Iowa causing their owners no more trouble after six to eight years use than becoming so hard that it is difficult to cut holes in the tile for a junction of lateral drains.

The experiments in question consisted in treating the cement with water for a definite period and calling the solids obtained by evaporating the solvent, cement dissolved from the specimen under test. At this stage, the experimenters seem to have stopped in order to spread the news. It would have been of interest had these same specimens been subjected to a repeated series of these tests as then one could have gained some information regarding the solubility of cement in concrete. Such a series might show that the solubility falls off very rapidly which from the composition of "market" cement one may assume, but such a result would be detrimental to the theory of the experimenters. If the rate of solution was found constant, then a conclusion as to the life of concrete might be drawn, but if a rapid decrease in the rate of solution be obtained no rational estimate of its life could be made unless the experiments extended over a long period of time and then one should be sure that it is the *bonding portion* of the cement that is dissolving and not the 60 per cent to 70 per cent of *non-cementing* particles which are disintegrating slowly under the action of time and moisture.

It will be noticed that the non-cementing portion of Portland cement is practically of the same composition as the cementing portion, the difference in activity being due principally to the difference in the size of grain. As setting of Portland cement is thought to be due to the hydration and crystallization of the active particles, it seems that after once being crystallized in the setting process, these particles will be practically immune from further action of water, but the larger grains which did not respond to the action of water at the time of setting will continue slowly to do so for a long period of time and if they increase in volume during this process of retarded setting, they constitute a menace to the integrity of the mass as their increase in volume will exert a force tending to destroy the bond of the particles which have gone through the setting process. This danger is guarded against in Portland cement specifications by requiring cement to pass tests for constancy of volume, but as all tests must necessarily be short, cement passing these tests may develop these defects in the course of time. Fine grind-

ing with the separation of the slow acting portions will in a measure increase the durability of cement by removing those portions which by their retarded hydration tend to cause the disintegration of the hardened mass. Results which have been charged to the solution of the bonding portion of Portland cement may be perhaps due to the part which at present is classed as non-active.

This feature may be remedied by fine grinding with refined separation; the extent to which these should be carried out is a problem resting with the economic production of Portland cement.

Respectfully,

A. O. ANDERSON.

Lake City, Iowa.

Oct. 17, 1908.

Methods of Deriving Benefits for County Drainage Systems in Missouri.

Sirs: I noted with interest the article on methods of deriving benefits for drainage systems in your issue of Oct. 21, 1908. Mr. Holman's plan is a very practical one for the kind of drainage proposition outlined and one, I think, which is generally used, with slight modifications to accommodate local conditions.

In the following discussion I wish to deal with a different kind of drainage proposition—namely: that of straightening and cleaning out a river or creek channel. In this case the shed line cannot always be used as the boundary line of land to be assessed for the improvement. The drainage commissioners and engineer in establishing the boundary line of such a drainage district must be governed, first, by the laws of the state in which the drainage district is located; second, by the natural lay and drainage of the land; and, third, by good judgment.

The drainage law of Missouri covering this point is as follows: "All lands benefited by public ditch, drain, water course or levee shall be assessed in proportion to the benefits for the construction thereof, whether the improvement passes through said land or not, and the viewers, in estimating the benefits to land not traversed by such ditch, shall not consider what benefits will be received after some other ditch or ditches shall be constructed, but only the benefits that will be received by the construction of the public ditch, as it affords an outlet for the drainage of such land. No assessment shall be paid for benefits to any land upon any other principle than that of such benefits derived; and no lands lying below shall be assessed for the benefit of the lands lying above, but all assessments shall be made on the basis of benefits accorded by reason of the construction of the improvement and of giving an outlet for drainage. In estimating damages, the viewers and county court shall take into consideration land and drains appropriated and the direction of the drain across the land."

I wish now to cite a concrete case one which came under my supervision, and show the method of determining the boundary line; also I would call attention to the fact that I shall endeavor to show wherein the law, as above recited, is not broad enough, and I should be pleased to have others express their opinion on the matter.

The creek that we shall take under consideration is about 70 miles long; it is proposed to straighten and clean out the lower end for a distance of 40 miles. The channel is very crooked and much filled with snags, logs and brush, and bars resulting from these obstructions. The stream flows in a general easterly direction. The bluffs are on the north; in some places these bluffs are two to three miles distant from the creek, and then again they are only 50 to 100 ft. away. To the south the land has a very gradual rise to the divide between the Missouri river and the creek; this divide varies from three to six miles in distance from the creek, and is about 3 ft. higher than the land adjacent to the creek.

In establishing the boundary line on the south the divide or shed line was used as much as possible, but on the north where the shed line extended in some places for several miles back in the bluffs and uplands, under the construction of the law this land could not be included in the drainage district because it would derive no benefit from the improvement; therefore the toe of the bluff line was taken as the north boundary line except where there were wide gaps in the bluff line and the low lands extended north along some tributary. At these places the boundary line included the low land along the tributary as far north as the

one-third of the debris, brush and logs in the main channel has been carried down by these precipitous streams. I would like to ask, is it justice that the farmer living in the low lands near a creek should be compelled to pay for cleaning debris out of the creek which has been deposited there through a customary though unlawful act of his upland neighbor?

But to return to the subject, having thus established the boundary line around the entire district, which is the first step in the process of deriving benefits, we must next divide the land lying in the district into first, second, third and fourth class benefits in much the same manner as described by Mr. Holdman. Each tract of land of 40 acres or less is considered separately and benefits assessed according to benefit derived from the proposed improvement. If the canal or ditch passes through a tract, damages are allowed, and the damages are subtracted from the benefits and the remainder set down under net benefits. After considering all the tracts of land in the district and having set down the number of acres, benefits, damages and net benefits, we next add up the different columns, checking across at the same time. If the district includes more than one township it is the better plan to add up each township separately and then make a summary sheet. With the total net benefits and the estimated cost of the improvement we are now ready to determine what percentage of the net benefits it will be necessary to levy as the estimated tax against the land. This report is submitted to the county court in the following form (25 per cent of the net benefits being taken to cover the estimated cost):

Name of land owner.	No. acres.	Description.	Sec.	Town.	Range.	Benefits.	Damages.	Net benefits.	Estimated tax.
John Jones.....	40	NENE	4	52	21	\$400	\$100	\$300	\$ 75.00
Chas. Smith.....	26.4	NWNE	4	52	21	264	...	264	66.00
Jas. Brown.....	38	NENW	4	52	21	570	70	500	125.00

land along the tributary had been made subject to overflow by reason of back water from the main creek. In several cases, where the bluffs were near the main creek, tributaries came down from the bluffs directly into the main creek. In these cases all that could be done was to follow the toe of the bluff line. It is in regard to just such cases as these that, I think, the drainage law is weak. These tributaries sometimes extend back into the hills and uplands for two or three miles. Some of these tributaries are heavily timbered and the owners and tenants of lands along them cast all their brush and snags into the channel. The first freshet that comes sweeps all this debris down into the main channel, where it lodges. Then the land is plowed and much silt from the bluff land washes down, helping to fill up the main channel. But when it comes to the matter of assessment for cleaning out the main channel because it has become so filled that it can no more take care of the flood waters, all this upland is exempt from taxation because it will not be benefited, while perhaps

After the report has been filed with the county court any land owner in the district who thinks his benefits too high or his damages too low may appear before the court and make complaint. If the complaint is sustained by the court the report is then changed and corrected to conform to the ruling of the court. After all corrections have been made we note whether our revised estimated tax total still covers the estimated cost of the work; if so, the report is adopted and the estimated tax then becomes the actual tax against each tract of land in the district. But if it is found that the estimated tax is less than the estimated cost the percentage is then raised and the estimated tax list revised throughout, and as so revised the report is adopted.

C. E. JACOBY.

Carrollton, Mo., Oct. 26, 1908.

According to statistics of the U. S. Geological Survey the total value of the mineral products of the United States in 1907 was \$2,069,289,196.

Methods and Costs; Some Old, Some New.

Life of a Creosoted Pipe.—The contractor for the McAdoo tunnels in New York city, in carrying on excavation on Sixth avenue between 18th and 19th streets, removed some wood conduits that were in perfect condition. These conduits proved to be creosoted wood conduit manufactured by the Wyckoff Pipe & Creosoting Co. of New York and were laid in 1887 and removed in 1908, thus being in the ground and in use 21 years. The conduit was removed and stored for future use.

Cost of Stop Cock Box Repairs, Etc.—From May 13 to Dec. 31, 1907, the Water Department of Cleveland, O., put 9,290 stop boxes to grade, besides replacing 1,803 old boxes with new ones. In addition 330 new stop cock boxes were put in and 10 new stop cock bottoms. The cost of the work according to the annual report of the Water Works Division of the Department of Public Service was as follows:

	Ave. Cost	
Boxes put to grade. 9,290	\$.4096	..
New boxes put in. 1,803	.8392	1,786
New tops put in. . . . 330	.4196	.879
New bottoms put in 10	.842	.920
Dug up and cleaned out 639	.8392	..

The wages paid for labor in Cleveland in 1907 were about as follows:

	Per Hour.
Foreman	\$.42
Assistant foreman.	.33
Labor	.22
Team	.50

Service Box for Underground Conduit.—In planning a conduit for the village of Canajoharie, N. Y., Mr. Charles E. Perry has designed a manhole somewhat similar to that of Mr. Wooley, mentioned in our issue of Oct. 14. The conduit is to be occupied by power, tel-

to add strength but to remove the possibility of injury to workmen employed about the low tension cables and to the cables themselves. The accompanying is a sketch of the service box, carrying out the idea.

Strength and Weights of Vitrified Pipe.—Tests were made in 1904 and 1905 at the Missouri State University laboratory at Columbia, Mo., and in the city of St. Louis, for the St. Louis Sewer Department, of 140 pieces of double strength vitrified clay pipe, 21 and 24 ins. in diameter, 2 ft. and 2½ ft. lengths, from seven different factories. The pipes were all loaded to the breaking point, and the average breaking load of the 140 pieces was approximately 5,600 lbs. per lineal foot of pipe. The areas and approximate weights of vitrified pipe sections are as follows:

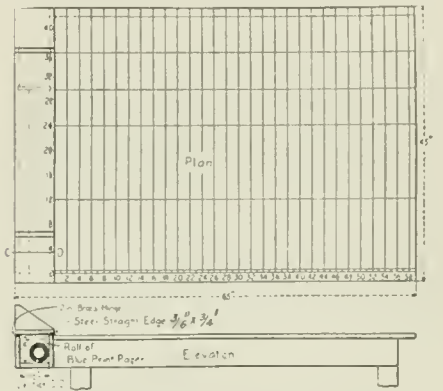
Inside Diameter, Ins.	Area in Sq. Ins.	Single Strength.	Double Strength.
		Weight per Lin. Ft. Lbs.	Weight per Lin. Ft. Lbs.
10	78	32	..
12	113	43	50
15	177	65	70
18	254	86	100
20	314	100	125
24	452	131	180
27	573	215	240
30	707	270	300
33	855	320	340
36	1,018	365	390

Cost of Pumping at Scranton, Pa.—

During the last fiscal year the total pumpage of the Maiden Creek pumping station of Scranton, Pa., was 2,259,191,840 gallons, without allowance for slip. The station is equipped with Worthington and Allis-Chalmers pumping machinery. Bituminous coal costing \$2.65 per gross ton delivered was used and 6,022,100 lbs. were consumed during the year. The wood used cost \$3.50 per cord, and an amount equivalent to 1,800 lbs. of coal was used. The average static head

was 100 ft. The principal items in the station expenses were: Coal, \$7,129.83; oiling and packing, \$1,010.73; firing boilers, \$967; running engines, \$907.54; unloading and stacking coal, \$601.76; superintendence and general work, \$528.43; oil and grease, \$603.86; tools and supplies, \$354.70; watching, \$300.74.

Blue Print Paper Cutting Table.—The accompanying illustration shows a table for cutting blue print paper which is used in the Engineering Drafting Department of the University of Colorado. It consists essentially of a table provided with a box along one end, which contains the roll of blue print paper. The box lid has a steel straight edge to guide the knife in cutting. The roll from which the paper is to be cut is placed in the box and the lid closed. The paper is then drawn out to the desired length,



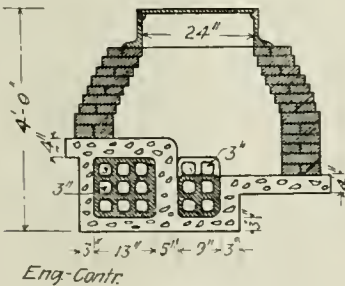
Blue Print Paper Cutting Table.

corresponding to that indicated by the scale at the front of the table and the cross ruling. A sharp knife drawn along the steel straight edge cuts off the paper. The handling of the blue print paper is greatly facilitated by the use of this simple contrivance. It can be quickly and accurately cut to the desired size, which makes it possible to use narrow margins beyond the tracing, and results in an economy in paper. The unused roll is never exposed to the light. The table was designed by Mr. J. H. Wallace, instructor in general engineering drawing at the University of Colorado, and is described in the Journal of Engineering of that institution.

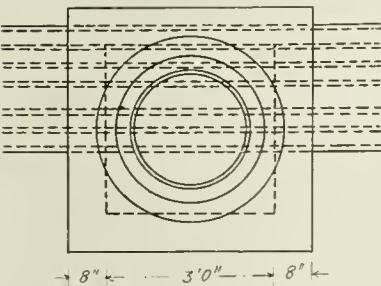
The status of work on the New York State Barge Canal up to Oct. 1 was as follows:

	Miles.
Work under contract.	164.0
Additional plans completed.	112.6
Plans over 75 per cent completed.	78.9
Other plans in progress.	87.0

During the month of September a total of 53,268 cu. yds. of concrete was laid on the several contracts for the construction of the New York State Barge Canal.



Service Box for Underground Conduit.



ephone and telegraph cables, and Mr. Perry's design contemplates that the high and low tension cables shall occupy structures that are separate entities throughout, although built in the same trench, his understanding of the function of the dividing wall in Mr. Wooley's manhole being that it is not

against which the pumps worked was 212.6 ft., and the average dynamic head was 291.8 ft. The number of gallons pumped per pound of equivalent coal was 375. The total cost of maintaining the pumping station was \$13,301.91, or \$5.89 per million gallons pumped, or 2 cts. per million gallons raised 1 ft. (dy-

The New School of Engineering at Northwestern University.

Mr. John Fillmore Hayford, chief of the Computing Division of the U. S. Coast and Geodetic Survey, has been elected director of the School of Engineering of Northwestern University at Evanston, Ill. This new school was founded by action of the board of trustees June 18, 1907, and in one sense may be said to be the outgrowth of certain work which has been given for some years in the College of Liberal Arts of Northwestern University.

For some years the College of Liberal Arts has offered courses for students planning for engineering. These courses extended through four years, but did not undertake to furnish complete technical instruction. The graduate needed one or two years in an engineering school to complete his engineering education. The gift of a building for engineering received from Mrs. Gustavus F. Swift and Mr. Edward Foster Swift was the occasion for the establishment of a school of engineering, to give complete instruction leading to an engineering degree. The building of the School of Engineering is nearing completion. It is situated between the library and the lake shore and is a stone building 54 ft. wide by 125 ft. long comprising an excellent basement, three full stories and an attic. The construction is designed to be superior throughout. The floor and stairways are of reinforced concrete so as to be thoroughly fire resisting. Special attention has been given to the lighting and to heating and ventilation.

The course of study in the School of Engineering will require five years of work for its completion and will also involve approved work for the summer vacations. The studies of the first four years of this course fulfill all requirements for the liberal arts degree of bachelor of science, and this degree is given to students at the end of the first four years of residence. The five year program has been adopted because of the broad requirements in cultural subjects, and because five years is thought to be none too long a time for an intelligent young man to spend in preparation for the higher positions in engineering. On the completion of the five year program a bachelor's degree in engineering will be conferred.

Mr. Hayford, the recently appointed director of the School of Engineering, was born at Rouse Point, N. Y., in May, 1868. He was graduated from Cornell University in the civil engineering course in 1889, and accepted an appointment as computer in the Coast and Geodetic Survey in June of that year. He served on the International Boundary Commission of the United States and Mexico in 1892, and was appointed instructor in civil engineering at Cornell

University in 1895. After three years at Cornell he received the appointment as expert computer and geodist of the Coast and Geodetic Survey, in the computing division of which he is now chief. Mr. Hayford is a member of the Philosophical Society in Washington, of the Washington Academy of Sciences, of the Astronomical and Astrophysical Society of American, of the American Association of Civil Engineers, and is a fellow in the A. A. A. S. He is the author of the Geodetic Astronomy and of numerous monographs in the government reports.

Drilling Holes in Brick Work with a Machine Drill.

In describing the moving of the Antwerp-Dam Station building, on the Belgian State Railways, in the Bulletin of the International Railway Congress, Mr. Albert Morglia, the engineer in charge of the work, tells of an interesting experience with machine drills on brickwork.

The building had been built 20 years, and as the price paid for the brick foundation work was only \$1.76 per cu. yd. it was thought that it would not be particularly strong, and the drilling of the holes to cut the building from its foundation could be done by hand. However, the foundation work proved to be particularly strong, consisting of gray brick and exceedingly hard mortar, and it was found to be a long and expensive matter to drill the holes, which measured 1 ft. 1 3/4 ins. square by 3 ft. 3 3/8 ins. in depth by hand. As there were 200 such holes to be made at an average depth of 4 ft. 3 in. below the ground level, some of them in places difficult of access, it was thought time would be saved by using machine drills.

Accordingly a pneumatic plant was installed at considerable expense. A compressor and a portable steam engine were located near the building and different varieties of drills were tried. In spite of many and persistent trials, the drills were not successful and had to be given up.

It is not stated what kind of drills were used, but they appear to have been pneumatic plug drills, for the brick dust blown from the holes by the exhaust air is particularly mentioned. The main trouble appears to have arisen because chips of brick broke off in drilling and blocked up the holes and jammed the drills. It then became impossible to drive the drill in or to draw it out, thus completely stopping the work.

As soon as the drills had penetrated 8 to 10 ins., it became impossible to use them any further. Accordingly the holes were drilled by hand. However, the machine drills were used to make some very shallow holes, 1 9-16 ins. in diameter, and not over 8 ins. deep.

The use of a water jet is not mentioned by Mr. Morglia. We are of the opinion that had a water jet been used, as described

in the 24th chapter of Gillette and Hills' "Concrete Construction—Methods and Cost," it would have been possible to drill this brick masonry with as much success as has been attained in drilling concrete, for concrete is notoriously hard to drill on account of the clogging of the drill bits, unless water jets are used.

Magnalium a New Alloy.

Magnalium is an alloy of aluminum and magnesium, manufactured in Germany (90% to 98% aluminum). For the following interesting notes on its characteristics we are indebted to Mr. Morris R. Machol, 32 Park Place, New York, who is the American agent of the Magnalium Syndicate of Berlin, Germany.

It is imported in pigs or ingots for castings or forgings and can be handled by the ordinary foundryman or blacksmith. It forges about like Swedish steel. It can be delivered in plates, bars, rods, wire, tubing, etc., and in any form it shows a far greater strength than aluminum in spite of its being lighter, its specific gravity being about 2.5 while that of pure aluminum is 2.64.

It shows the following tensile strength in lbs. per sq. in.: Castings 19,000 to 42,000, forgings 30,000, annealed and hard rolled plates 42,000 to 52,000 respectively, drawn rods, 60,000, wire 42,000 to 52,000, tubing 74,000.

The various other claims made for it are given below. It can be worked or machined about like brass, giving a smooth surface of silver color. Clean, sharp holes can be bored and perfect screw threads can be cut in the metal. The finest files can be used on it successfully. The tool speed is about twice that of aluminum.

It attains and maintains a high polish, resists oxydization, is unaffected by dry or damp air, water, gaseous ammonia, carbonic acid, sulphurate of hydrogen and most organic acids. It is very slightly affected by saltpeter or sulphuric acid and more rapidly by alkalis or strong alkaline solutions. It is slightly attacked by salt water and should be lacquered where it is exposed to sea water.

Magnalium, unlike aluminum, can be soldered by any ordinary workman with magnalium solder after a little practice. Its electric and thermal conductivity is 50 per cent of that of pure copper. The melting point is 1185 to 1250 degrees F., the specific heat 0.2185.

It is extensively used for airships, automobiles, bicycles, gasoline engines, kitchen utensils, spinning, weaving and milling machinery, steam, water and floating valves, instruments and many other articles. In general the price of magnalium is not so much higher than that of aluminum as to make it more expensive to use because less magnalium is required on account of its greater strength per unit of cross section and lesser unit weight.

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are. First, to inform civil engineers and contractors of the articles and papers of merit that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

- American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.
American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.
American Engineer and R. R. Journal (Am. Engr. & R. R. J.), New York, N. Y.; m; 7x10 in.; 20 cts.
American Gas Light Journal (Am. G. L. J.), New York; N. Y.; w; 10x13 in.; 10 cts.
American Institute of Electrical Engineers Proceedings (Am. I. of E. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
American Machinist (Am. Machst.), New York; w; 7x10 in.; 15 cts.
American Society of Civil Engineers Proceedings (Am. Soc. C. E. Proc.), New York, N. Y.; m; 4x7 in.; 75 cts.
American Society of Mechanical Engineers Proceedings (Am. Soc. M. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
Annales des Ponts et Chaussées (An. P. & C.), Paris, France; m. Architects and Builders Journal (Arch. & Bldrs. J.), Baltimore, Md.; m; 9x12 in.; 20 cts.
Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
International Railway Congress Bulletin (Int. Ry. Cong. Bul.), Brussels; m; 50 cts.
California Journal of Technology (Cal. J. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x19 in.; 20 cts.
Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
Canadian Mining Journal (Can. Min. J.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
Canadian Municipal Journal (Can. Mun. J.), Montreal, Que.; m; 6x10 in.; 10 cts.
Canadian Society of Civil Engineers Proceedings (Can. Soc. C. E. Proc.), Montreal; m; 4x7 in.; 50 cts.
Carpentry and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
Cement Age (Cem. Age), New York, N. Y.; m; 4x7 in.; 10 cts.
Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
Electric Railway Journal (Elec. Ry. J.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electric Traction Weekly (Elec. Trac. Wkly), Cleveland, O.; w; 7x10 in.; 10 cts.
Engineer (Engr. Lon.), London, England; w; 4x11 in.
Engineer (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Engineer (Eng.), London, England; w; 8x11 in.
Engineers' Club of Philadelphia Proceedings (Engr.' Club, Phila., Proc.), Philadelphia; q; 4x7 in.; 25 cts.
Engineering-Contracting (Eng.-Contr.), Chicago, w; 7x10 in.; 10 cts.
Engineering Digest (Eng. Dig.), New York; m; 5x8 in.; 20 cts.
Engineering and Mining Journal (Eng. & Min. J.), New York; w; 7x10 in.; 15 cts.
Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.
Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
Le Genie Civil Paris, France; w.
Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.
Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.
Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; \$1.
Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.
Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
Iron Trade Review (Iron T. Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.
Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
Journal of Electricity, Power and Gas (Jl. Elec., P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Mining and Minerals (Mi. & Ms.), Scranton, Pa.; w; 7x9 in.; 20 cts.
Mining and Scientific Press (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Modern Machinery (Mod. Mch.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Municipal Journal and Engineer (Mun. J. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.
Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 in.; 15 cts.
Power and Engineer (Pwr. & Engr.), New York; m; 7x10 in.; 20 cts.
Railway Age Gazette (R. R. Age. Gaz.), New York; w; 8x11 in.; 15 cts.
Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Roadmaster and Foreman (Rd. & For.), Chicago; 7x10 in.; 10 cts.
Rock Products (Rk. Prod.), Chicago, Ill.; bi-w; 9x11 in.; 10 cts.
Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; q; 4x7 in.; 50 cts.
Schweizerische Bauzeitung, Zurich; w.
Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
Sibley Journal of Engineering (Sib. J. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.
Technology Quarterly (Tech. Qr.), Boston; q; 4x6 in.; 35 cts.
U. S. Department of Agriculture Bulletin (Dept. Agr. Bul.), Washington, D. C.; 4x7 in.
U. S. Geological Survey Bulletin (Geo. Surv. Bul.), Washington, D. C.; 4x7 in.
Waterproofing and Fireproofing (W. P. & F. P.), New York, N. Y.; m; 5x8 in.; 10 cts.
Zeitschrift d. Oest. Ing. u. Arch. Ver. Vienna; w.
Zeitschrift d. Ver. Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Dust Preventives. By Prevost Hubbard, Dept. Agri. Public Roads Bulletin No. 31, 64 pp.

A very useful and comprehensive pamphlet on dust preventives. Classifies preventives. Takes up tars, their manufacture and application. Then considers oils, their classification and properties and their application, also their applying to macadam, gravel roads and earth roads. Then water and salt solutions are discussed, and temporary tar and oil binders, and emulsions, and similar preparations. The selection of dust preventives is commented upon at some length, and the examination and tentative specifications for them are discussed.

Road Tarring and Vegetation. Mun. Jl. & Engr., Oct. 28, 1908. 1 1/2 pp.

Gives the opinions of several English and American engineers on the effect of tar on shade trees and other vegetation.

Mineral Rubber Road Surfacing. Mun. Jl. & Engr., Oct. 21, 1908. 2 pp.

Describes type of pavement that has been laid on several roadways in the South Parks, Chicago, Ill. The pavement consists of limestone, mixed well with 8 to 10 per cent of sarco asphalt, in a special mixing machine, and applied at a temperature of about 300 degrees.

The Destructive Effect of an Automobile Race on Roads. Eng. Rec., Oct. 10, 1908. 1 p.

An account showing the destructive effect of automobiles while racing on the roads used when the Grand Prix of the Automobile Club of France was run in 1906. The effect of the automobile on several classes of roads is described.

Maintenance of Highways in View of the Advent of the Motor Vehicle. By Clifford Richardson. Eng. Rec., Oct. 17, 1908. 2 2/3 pp.

A paper read before the International Road Congress at Paris. Reviews work done in this connection in the past, and points to what is necessary in the future, and suggests the use of bituminous or asphaltic materials as binders in road building.

Macadam Roads. By Austin B. Fletcher. Farmer's Bul. 338, Dept. Agri., Oct. 17, 1908. 39 pp.

In this pamphlet the author presents considerable data on macadam roads. Discusses stone for road work, tools and machinery, earthwork, drainage, the actual building of the macadam, how to treat roadsides, cost of construction, the need and methods of maintenance, and other features of road work. In an appendix specifications for roads used by the State of Massachusetts are given, and sketches of various kinds of culverts for roads are shown.

The Cost of an Oiled Sand Road in Massachusetts. Eng.-Contr., Oct. 7, 1908. 2 3 p.

The road, a common sand one, was treated in 1905 with a heavy Texas oil, containing about 65 per cent of asphalt. Two applications were made in 1905 and one in 1906. The article gives the methods and costs of these applications.

Dust Preventives: Tars, with Methods of Analysis and Suggested Specifications for Their Use. Eng.-Contr., Oct. 14, 1907; 2 1/3 pp.

The article describes briefly the method of manufacturing the tars used as dust preventives and defines the qualities a tar should have to be used successfully in road work. Simple methods for examination of tars and tentative specifications in the use of tars as dust preventives are given.

Method and Cost of Constructing Tar-Macadam, Tar-Pitch-Macadam and Tar-Asphalt-Macadam Roads in Rhode Island. Eng.-Contr., Oct. 7, 1908; 2 2/3 pp.

Describes experiments conducted in 1907-08 by the State Board of Public Roads of Rhode Island, on the construction of tar-macadam, tar-pitch-macadam, tar-asphalt-

macadam, asphalt-macadam and tar-pitch-macadam roads. The methods of construction, the various conditions under which the experiments were made and the costs of the various kinds of road are given.

Dust Preventives: Oils, with Methods of Analysis and Suggested Specifications for Their Use. Eng.-Contr., Oct. 21, 1908; 2 pp.

Describes the various oils used as dust preventives, their source, qualities and methods of refining, and gives simple methods of examination to determine their values as dust preventives. Tentative specifications for their use as dust preventives or road preservatives are also given.

Specifications and Notes on Macadam Road Construction. Eng.-Contr., Oct. 28, 1908; 4 1/3 pp.

Abstract of a very interesting paper by Mr. A. N. Johnson, State Highway Engineer of Illinois, read before the Western Society of Engineers. Mr. Johnson gives the concise wording of the specifications, followed by explanatory notes, explaining the reason for the form of construction. The article forms an excellent commentary on modern methods of macadam road construction.

The Oiled Roads of Santa Monica, Cal. By C. B. Irvine. Mun. Eng. Mag., October, 1908; 1 p.

Describes the method of constructing petroliothic roads at Santa Monica.

Cost of Scarifying Macadam in Rhode Island. Eng.-Contr., Oct. 28, 1908; 1/3 p.

Gives detailed costs of breaking up crust of old macadam road, preparatory to mixing it with tar or asphaltic oil. A scarifier, drawn by a steam roller, was used.

How Tar-Macadam Roads Are Built Near Detroit, Mich. Gd. Rds. Mag., October, 1908; 1 1/2 pp.

Specifications adopted by the Commissioners of Wayne County, Michigan, for building tar-macadam roads.

Does Tar Injure Roadside Trees? Gd. Rds. Mag., October, 1908; 1 1/2 pp.

Replies from various highway engineers in answer to the question whether the use of tar on roads damages the trees and vegetation bordering such roads. The replies indicated that no ill effects had been observed.

Building a Road to Sustain Automobile Traffic. Gd. Rds. Mag., October, 1908; 5 pp.

Describes the construction of the Long Island Motor Parkway, a road built especially to withstand automobile traffic under its most destructive conditions. As this road will be used for automobile races, an interesting deviation from ordinary methods of highway construction was introduced at the curves. The metalling was on the Hassam system, with the exception that the concrete was reinforced with wire netting.

Road Improvements and Resurfacing Experiments. By Harold A. Hosking. The Surveyor, Oct. 2, 1908; 2 pp.

The writer considers the damages caused to roads by various forms of traffic, and finds that the greatest damage is caused by the compression or crushing of the road surface under the great weight of the heavy motor traffic. The suction of motor tires and the abrasion of road surface are also considered. Details of experiments with tar, tarvia and surface spraying are given.

Road Tarring and Its Effects on Trees and Plants. Surveyor, Oct. 2, 1908; 1 p.

Editorial note citing opinions in which it is claimed that road tarring has a beneficial effect on the neighboring trees and plants. Also two letters from city engineers stating that they had observed no damage from the above cause.

Modern Road Management. By E. Purnell Honley. Surveyor, Oct. 16, 1908; 2 pp.

A paper read before the Paris International Road Congress. In it the author discusses in a general way the road conditions in the County of Notts, England.

Important New Books

Sewage Disposal Works

By HUGH P. RAIKES,
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In view of the fact that many millions of dollars are spent annually on Sewage Disposal Works, it is of the greatest importance, in the interests both of economy and of public health, that those who are entrusted with the design and construction of such works or with the expenditure of public money upon them, should not only clearly understand the essential principles involved, but should also have at their disposal the latest results of contemporary experience to guide them in the practical application of those principles.

The author of the present book has presented an impartial review of the modern methods of sewage purification, and has produced a practical and up-to-date work on the subject. We can, without hesitation, highly recommend this book to all engineers interested in this important and timely subject.

CONTENTS:

- Introduction.
- Chapter I—Alternative Methods of Treatment and Preliminary Considerations Affecting the Design and Construction of Works
 - " II—Diffusion in Tidal Waters.
 - " III—Irrigation and Land Filtration.
 - " IV—Removal of Matters in Suspension by Screening and Treatment in Tanks.
 - " V—Chemical Precipitants and the Disposal of Sewage Sludge.
 - " VI—Filtering Media for Bacteria Beds.
 - " VII—Contact Beds and their Operation.
 - " VIII—Percolating Filters. Alternative Methods of Construction and Working.
 - " IX—Distribution over Percolating Filters.
 - " X—The Separation and Disposal of Storm Water.
 - " XI—Purification of Trade Wastes.
 - " XII—Maintenance and Management of Sewage Disposal Works.
- INDEX.

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Road Tarring and Its Effects on Trees and Plants. Surveyor, Oct. 9, 1908; 1 p.

An interview with Dr. Guglielminetti, Secretary of the French Society for the Prevention of Dust on Roads, in which it is shown that the rumor as to the damages to trees and plants in the Avenue du Bois de Boulogne arising from road tarring is absolutely without foundation.

Municipal Stone Bins and Trestle. Mun. Jl. & Engr., Oct. 14, 1908; 1½ pp.

Describes the combined trestle and stone bin used by the Street Department of Springfield, Mass., for the storage of crushed rock. The bins and trestle are constructed of reinforced concrete.

Iron-Slag Block for Street Paving. Eng. News, Oct. 8, 1908; 1 p.

Describes briefly methods of manufacture of iron slag paving blocks and their characteristics and the possibilities of production in the United States. Some records of European experience are stated, and a more complete account of recent American experience in Brooklyn, Philadelphia, Toronto, Montreal, Quebec and Baltimore.

SEWERS.

Large Concrete Sewer Constructed with Adjustable Metal Forms. By John M. Bruce. Eng. News, Oct. 8, 1908; 2 1/3 pp.

General description of large reinforced concrete sewer and of metal forms used in its construction, with an account of the methods of trenching and of mixing and placing the concrete and handling the forms. Clam shell excavators and cableways were used for trenching; the forms used were those known as "Duralite" metal forms.

The Relative Action of Sand, Contact and Sprinkling Filters on Organic Matter. Eng. Rec., Oct. 24, 1908; 1 p.

An account of organic matter removed from sewage by different types of filters as compiled by H. W. Clark, chemist of the Massachusetts Board of Health from records of the Lawrence Experiment Station.

The Cost of Excavating and Laying Pipe Sewers. Engr.-Contr., Oct. 21, 1908; 1/3 p.

The cost is given for eleven examples of pipe sewer work in Holyoke, Mass., showing the cost of pipe per lineal foot, the cost of materials and labor, the total cost, the total cost per lineal foot, the amount and size of pipe laid and the class of material excavated.

A Sand and Gravel Separating Basin on a Storm Water Sewer. Eng. Rec., Oct. 24, 1908; 1 p.

A description is given, accompanied by drawings, of a basin built to separate gravel and sand, thus preventing it being deposited in the sewer. Work located at Grand Rapids, Mich.

Royal Commission on Sewage Disposal. Surveyor, Oct. 2, 9, 16, 23, 1908; 12 pp.

A review by Mr. H. C. H. Shenton of the fifth report of the Royal Commission on Sewage Disposal, upon methods of sewage disposal. In the review the various sections of the report are treated in some detail, some of the subjects considered being as follows: Preliminary processes for the removal of suspended matter; contact beds; percolating filters; relative efficiency of contact beds and percolating filters; purification of sewage by treatment on land, etc., etc.

Sewage Disposal in Columbus, O. Mun. Eng. Mag., October, 1908; 5 pp.

A general description of the recently completed sewage disposal work of Columbus.

Cost of Sewers in Springfield, Mass. Mun. Jl. & Engr., Oct. 14, 1908; ½ p.

Gives cost per lineal foot of constructing a number of plain concrete sewers.

Cost of Constructing a Brick Sewer in Water Soaked Sand at Gary, Ind. Eng.-Contr., Oct. 7, 1908; 1 1/3 p.

The sewer was 4.258 ft. long, through water soaked fine sand. The sand was drained by bleeding with well points. The itemized costs of excavation, sheeting pumping, haul-

ing materials, sewer construction and brick filling are given. A valuable record of an unusual piece of construction.

Sewage Disposal in England. Mun. Jl. & Engr., Oct. 7, 1908; 4 pp.

A synopsis of the fifth report of the Royal Sewage Commission on Sewage Disposal, of Great Britain.

WATER-WORKS AND HYDRAULICS.

Progress on the Buffalo Water Works Improvements. Eng. Rec., Oct. 10, 1908; 4 pp.

The general plan of increasing the water supply for the city, with a description of the progress made on the work. Intake crib and tunnel are especially described and illustrated.

Experience in the Use of Gasoline Engines and Kerosene Engines, or Combinations of Same, for Water Supply, Drawbridges, etc. Proc. Asso. Ry. Supt. B. & B., October, 1908; 12 pp.

Report of committee having in charge this subject. Gives some tables showing the cost of pumping by these methods per 1,000 gallons. Also records the experience of several railroads using such pumps.

Water Works of Cleveland. Mun. Jl. & Engr., Oct. 7, 1908; 4½ pp.

Data from the annual report of the Water Works Division of Cleveland, O. Included are specifications used by that city for the purchase of water meters. A table is also given, showing the cost per lin. ft. of pipe laid during 1907.

French Pipe Cleaning Apparatus. Mun. Jl. & Engr., Oct. 28, 1908; 1 p.

Describes a contrivance used in France for removing scale and deposit from water mains. The apparatus is operated by a motor and pulverizes rather than scrapes out the tubes' deposit.

Blue Island Ave. Tunnel for the Chicago Water Works System. Eng. News, Oct. 22, 1908; 2 pp.

Shows maps and shaft construction of this new 8-ft. circular water supply tunnel and describes methods of construction. The tunnel is through clay and is concrete lined.

The Nine-Mile Hydro-Electric Development on the Spokane River. Eng. Rec., Oct. 10, 1908; 2 pp.

A detail description of the designing of this power development and of the building of the dam and installation of the machinery in the power house, with the amount of power developed.

Methods and Results of Cleansing Water-mains in Pittsburg, Pa. By C. O. Doughday. Eng.-Contr., Oct. 7, 1908; 1 p.

Describes briefly method of cleaning 6, 8 and 4-in. watermains from tubercular formations and mud, with tabular statements of diameters, velocities, discharges, etc., before and after cleaning. A suggestive article to water works officials.

DRAINAGE AND IRRIGATION

Tile Underdrainage. By J. J. W. Billingsley. Clay Worker, October, 1908; 3 pp.

A discussion of tile drainage under the headings of what soils need tile draining, general plans, outlets, size of tile, depths of drains, width apart of drains, ditch digging and tile laying.

Construction of the Pathfinder Dam, North Platte Project, U. S. Reclamation Service. By E. H. Baldwin. Eng. News, Oct. 29, 1908; 3 pp.

General description of a curved masonry dam, 218 ft. high and 425 ft. long, with a more detailed description of the construction plant and methods of construction. A very good general account of a large masonry job.

Methods and Cost of Constructing a Farm Drainage System. Eng.-Contr., Oct. 21, 1908; 2 2/3 pp.

Beginning of a continued article describing in detail methods and cost of constructing an open ditch and tile drainage system for a 477-acre farm. A valuable and interesting record of farm drainage methods and costs.

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Methods of Deriving Benefits for County Drainage Systems in Indiana. By Philip Holman. Eng. Contr., Oct. 21, 1908; 1 p.

Explains in detail method of making plats and figuring and apportioning benefits for county drainage work.

RIVERS, HARBORS AND CANALS.

Proposed Reservoir System in Ohio River Basin. By H. G. Newcomer. Eng. News, Oct. 8, 1908; 413 pp.

A general argument against reservoir control of the Ohio River, with a full estimate of the cost of such a system of reservoirs, showing it to be much greater than assumed in the paper by Mr. M. O. Leighton before the Inland Waterways Commission. An adversely critical discussion of reservoir control of rivers; a paper of great interest.

Improvement of the Ohio River for Navigation. Eng. News, Oct. 8, 1908; 3 pp.

Summary from official reports of the character of the Ohio River, its traffic, and the work done and planned for to improve it for navigation.

Flood Protection in Grand Rapids, Michigan. Eng. Rec., Oct. 31, 1908; 3 pp.

An account of the flood protection needed in this city, which has been provided at a cost of a million dollars. In addition to the concrete wall built along the Grand River, several large sewers had to be built, at a cost of \$500,000. The details of the work are described.

The David Neale System of River Improvement and Bank Protection. By E. H. Miller. Eng. News, Oct. 22, 1908; 3½ pp.

Reviews various approved methods of bank protection by brush mattresses, and describes in detail the David Neale system, consisting, briefly, of layers of bundles of brush, bound together by wires, and used in connection with dikes. The method of construction is described in detail, and general figures of cost are given.

The Extension of Governor's Island, New York Bay. Eng. Rec., Oct. 24, 1908; 2 pp.

An account of the seawall being built by the government and the additional land being made behind the seawall. The outfit used on the work is described.

The Improvement of the Harbor of Milwaukee, Wis. Eng. Rec., Oct. 24, 1908; 3 pp.

A description is given of the work being done by the United States government in improving this harbor, making a harbor of refuge by means of a break water. The plant used in doing the work is also described.

The Proposed Extension of the Chicago Drainage Canal as a Deep Waterway to the Illinois River. Eng.-Contr., Oct. 14, 1908; ¾ p.

Report of Internal Improvement Commission relating to work required, structural features and cost of a 14-ft. waterway from Lockport, Ill., to the Illinois River.

Method of Closing the Point Beka Crevasse, Mississippi River, Louisiana. By F. W. Kerr. Eng.-Contr., Oct. 7, 1908; 2 pp.

Describes occurrence, dimensions and character of crevasse, and then outlines methods of work adopted in closing it by means of pile cribbing filled with stone. A good description of emergency repair work.

Forests and Floods; Extracts from an Austrian Report on Floods of the Danube, with Applications to American Conditions. By H. M. Chittenden. Eng. News, Oct. 29, 1908; 4½ pp.

An elaborate and extremely interesting argument to show that the stock arguments for forest preservation because of the relation of forests to floods, low water and protection of the soil from erosion are all founded on popular fallacies.

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RAILWAYS.

Proposed Freight Subway Belt Line for Lower New York City. By Francis W. Lane. Eng. News, Oct. 18, 1908; 2 2/3 pp.

Summary from report of Mr. W. J. Wilgus, outlining plans for a freight subway under the marginal streets of Manhattan, and connecting with the railways terminating in New Jersey. Maps, profiles and typical sections are shown, with estimates of tonnage and costs of handling freight. A notable suggestion for the improvement of handling freight by railway in the city named.

Method of Lining the Second Bergen Hill Tunnel of the Lackawanna Railroad. Eng. Rec., Oct. 31, 1908; 1 1/3 pp.

A description of the method used in lining this railroad tunnel, together with the outfit used and the forms, the latter being of a special design, that were readily moved through the tunnel as the work progressed.

The Building of the New Canadian Transcontinental Railroad. By George C. McFarlane. Eng. Mag., November, 1908; 13 pp.

A very interesting article descriptive of the work being done in building the new transcontinental line of the Grand Trunk Pacific. The article is general to a great extent, but includes description of methods of subcontracting the excavation and also of methods used in blasting rocks, with some comments on blasting. Also gives costs of building the most expensive section of 200 miles.

Some Special Designs of Rails and Tie Plates. Eng. News, Oct. 15, 1908; 1 p.

Describes and shows sections of rails used on the Western Pacific and the Great Northern railways, and details of special tie plates used on the Kansas City Southern, the Central R. R. of New Jersey, the New York, New Haven & Hartford, and the Chicago, Rock Island & Pacific railways.

Cost of a Railroad Resurvey. Eng.-Contr., Oct. 14, 1908; 1/3 p.

Gives some general figures of cost for a railroad resurvey in New Brunswick.

Steel Rails for Present Service; Their Manufacture and Their Failures. By Dr. P. H. Dudley. Can. Eng., Oct. 2, 1908; 4 1/2 pp.

A paper read before the Western Society of Engineers. Discusses the use of rails and the defects in track, with the use of heavier and stiffer rails to remedy such defects. The manufacture of rails is treated at some length, especially as touching on rail failures and defects. The failure of rail heads is also discussed. The fact that the manufacturers are co-operating with the rail users to overcome some of the failures caused by the process of manufacturing is commented upon.

The Wear of Rails of Special Steels. Eng. Rec., Oct. 24, 1908; 2/3 p.

Results are given of a study made by Mr. H. M. Steward, Roadmaster of the Boston Elevated Railway Co. This road has curves aggregating 40 per cent of the whole line, and the wear of the rail on these curves has been excessive. A study has been made of various steels to reduce this wear.

Electric Traction vs. Steam Railroad Operation. By W. H. Evans. Cen. Ry. Club, September, 1908; 7 pp.

A paper of general interest regarding the use of electricity and steam for the operation of railroads, showing to some extent the progress made by electricity in this field, especially in replacing steam power.

Cost of Tracklaying. Eng.-Contr., Oct. 7, 1908; 1 p.

Points out the various items entering into the cost of tracklaying, giving particular attention to the item of train service, and gives actual costs in a variety of cases.

Methods of Protecting Embankments from Effects of High Water by Riprap or Otherwise, and Some Statements of Costs. Eng.-Contr., Oct. 28, 1908; 3/4 p.

Describes practice on three different rail-

ways, giving methods and stating results. General costs of work are stated.

BRIDGES, BUILDINGS AND FOUNDATIONS.

Traveler for Bridge Erection. By L. L. Jewell. Eng. News, Oct. 8, 1908; 1 1/2 pp.

General description, with outline drawings, and main dimensions of steel traveler used in erecting plate girder viaduct on the Virginia Ry. In general the traveler is a steel tower carrying long steel cantilever arms both front and rear, on the bottom chords of which is a crane runway. The total length of the traveler is 220 ft., with a 100-ft. forward arm, a 60-ft. tower and a 60-ft. rear arm. The structural features and the mechanical equipment of the traveler are fully described.

Substructure of Farmers' Loan & Trust Co.'s Building, New York. Eng. Rec., Oct. 31, 1908; 2 1/2 pp.

Describes the foundation work done on this building, pneumatic caissons being sunk to solid rock. A feature of special interest is the timber props and braces used to shore the adjoining buildings while the foundation work was in progress. Drawings are shown of them.

Masonry Arch Bridge Across the Connecticut River at Hartford. Eng. News, Oct. 22, 1908; 1 p.

General description of nine-span stone arch bridge, 1,192 ft. long, with spans from 68 to 119 ft.

Pile and Frame Trestle Bridges. Asso. Ry. Supt. B. & B., October, 1908; 11 pp.

Report of committee showing the custom followed by various railroads, showing method of fastening rail to ties on such bridges, devices used to prevent rails from creeping, the kind of metal guard rails used, the length of keys of the trestle, size and kind of timber used for caps, stringers, ties and piles, life of such members, and to what extent concrete piles have been used.

Methods of Erecting Truss Bridges. Asso. Ry. Supt. B. & B., October, 1908; 20 pp.

Report of committee having this subject in charge. Shows by description and illustrating the methods used on several railroads in erecting trusses and some girders. A number of full-page illustrations are given.

Waterproofing of Concrete Covered Steel Floors of Bridges. Proc. Ry. Supt. B. & B., October, 1908; 27 pp.

Report of committee showing a large number of methods of waterproofing solid floors of steel bridges. Drawings showing the methods are given.

Construction of Cofferdams. Proc. Ry. Supt. B. & B., October, 1908; 14 pp.

Report of committee on cofferdams, in which several small coffer dams are described, and methods of building them shown.

Work of Raising and Moving the Antwerp Dam Station Building. By Albert Morglia. Int. Ry. Cong. Bul., October, 1908; 31 pp.

An article describing the moving of a large station building from one site to another, over a low piece of ground where water accumulated during rainy weather, the work being accomplished in a highly satisfactory manner. The article is an excellent one, as every detail of the work is described, and it is well illustrated with drawings and photographs, thus making it a guide in doing work of a similar character.

Renewing Foundations of Water Tank. By William Martin. Mun. Jl. & Engr., Oct. 21, 1908; 1 1/2 pp.

Describes method of moving water tank in order to put in new foundations. Tank was moved by floating in temporary reservoir built for that purpose.

Data on Fourteen Steel Bridges (Highway and Railway), Including Weights, Costs, etc. Eng.-Contr., Oct. 7, 1908; 1 3/4 pp.

These data relate chiefly to spans of considerable size, and give dimensions, assumed

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loads, general character of construction, weights, and, in some cases, costs. A valuable article for those making estimates on long-span bridges.

Statistics as to the Life of Steel Railway Bridges. Eng.-Contr., Oct. 7, 1908; 3/4 p.

Points out fallacy of assumption that steel bridges are permanent, and shows actual life in years of a large number of steel railway bridges.

Weight and Cost of Steel in Brooklyn Elevated Railways. Eng.-Contr., Oct. 7, 1908; 1/4 p.

Describes general character of construction, gives itemized weights and general costs.

Cost of the Early Elevated Railways in New York City. Eng.-Contr., Oct. 7, 1908; 1/4 p.

Gives cost per mile of structure and equipment for elevated railways of New York city up to 1880.

CONCRETE AND REINFORCED CONCRETE.

Reinforced Concrete Reservoirs for the Indianapolis Water Co. By William Curtis Mabce. Eng. News, Oct. 15, 1908; 1 1/2 pp.

The reservoir is 257x377 ft., of reinforced concrete, with groined arch floor, plain walls, and slab and girder roof, carried by columns. The article gives the general structural portions, describes briefly the construction methods, and gives the cost of the whole work and also of some of its parts separately in units of per square foot water surface.

Constructing a 25-Ft. Sidewalk with Concrete Mixers. Eng.-Contr., Oct. 28, 1908; 1/3 p.

Describes the construction of a 25-ft. concrete walk on Michigan Ave., Chicago, Ill.

A Method of Enlarging Column Footings. By John E. Conzelman. Eng. Rec., Oct. 31, 1908; 2/3 p.

Describes and illustrates by drawings a very ingenious and satisfactory method of enlarging a column footing. The original footing was of concrete, the enlargement being of reinforced concrete.

Reinforced Concrete Caissons for a Breakwater at Algoma, Wis. By W. V. Judson. Eng. News, Oct. 15, 1908; 1 p.

Describes the design and construction of the concrete caissons built on shore, floated to place and sunk on piles to form a breakwater.

Reinforced Concrete Construction by the Works Construction Force. By Warren H. Miller. Eng. Rec., Oct. 10, 1908; 2 pp.

In this article the author gives a number of excellent suggestions and makes critical comment on building concrete structures, especially reinforced buildings. Some general costs are given of building a reinforced concrete shop.

Handling Concrete with Belt Conveyors. Eng. Rec., Oct. 10, 1908; 1 1/3 pp.

An account of the extensive belt conveyor system being used by the Fort Orange Construction Co. for handling materials to the mixer, and also concrete from the mixer to the forms, on their work on the State Barge Canal of New York.

Bridge Work, Balustrades and Ornamentation in Cast Stone. By Paul Wilkes. Concrete, October, 1908; 3 1/4 pp.

Shows construction of molds and describes methods of mold making and molding for cornice, base, balustrades and coping for a bridge. A good article on a subject that is not well known.

Development of a Practical Type of Concrete Spillway Dam. By Richard Muller. Eng. Rec., Oct. 21, 1908; 1 1/2 pp.

A discussion of the design of a spillway dam. The assumptions are set forth and the mathematics given for a design for which a drawing is shown.

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A Concrete Caisson Well. By G. E. P. Smith. Cem. Age, October, 1908; 5 pp.

Describes construction of a well 8 ft. in diameter and 24 ft. deep, by sinking a reinforced concrete caisson and excavating inside. Details of the forms are shown. An interesting account of an unusual piece of work.

Retaining Walls. Bulletin No. 5 of the Expanded Metal and Corrugated Bar Co., of St. Louis, Mo., in their series of Designing Methods Reinforced Concrete Construction, October, 1908; 26 pp.

This bulletin contains a discussion of special problems met with in the design of retaining walls, with a brief discussion of the subject of earth pressures, also detailed designs of both cantilever and buttress type of retaining wall, with earth fill level with wall and also surcharged.

Combined Concrete and Steel Girder Bridge, Monroe St., Brookland, D. C. By W. J. Douglass and W. P. Darwin. Eng. News, Oct. 29, 1908; 12/3 pp.

This bridge has concrete abutments and a 60-ft. girder span, consisting of steel girders embedded in concrete. The steel was designed to take directly a portion of the loads and to support the forms for the concrete work. The structural portions of the bridge are shown with details of the forms. The design is discussed in a general way.

Labor Cost of Concrete Curb, Cement Sidewalks and Brick Pavement at Gary, Ind. By E. M. Scheffow. Eng.-Contr., Oct. 14, 1908; 1/3 p.

Gives labor cost of mixing concrete and placing cement curb; also labor cost of constructing cement sidewalk with $\frac{3}{4}$ -in. wearing surface and $3\frac{3}{4}$ -in. concrete foundation, and laying brick pavement on natural sand foundation.

Cost of Constructing Two Concrete Sidewalks. Eng.-Contr., Oct. 7, 1908; 1/3 p.

Gives detailed costs of constructing two concrete sidewalks having 1-in. cement surface, $3\frac{1}{2}$ -in. concrete base and 4 in. of cinders on gravel foundation.

Painting Cement Surfaces. By P. W. Nelson. Mun. Eng. Mag., October, 1908; 1 p.

A paper read before the Ohio State Association of Master House Painters and Decorators. Several methods of doing the above work are given.

Placing Concrete in Freezing Weather. Eng.-Contr., Oct. 14, 1908; 1/3 p.

Describes method of raising temperature of water from near the freezing point to about 45 degrees F. in the placing of concrete for an ore dock.

Cost of Reinforced Concrete Culvert. Eng.-Contr., Oct. 21, 1908; 1/3 p.

Gives detailed costs of constructing a 4-ft. reinforced concrete box culvert.

Concrete Culvert Building on a Large Scale. By B. W. Spencer. Gd. Rds. Mag., October, 1908; 3 pp.

Illustrates and describes the type of reinforced concrete culverts used in carrying a stream of steam under various streets. The work was done in connection with a tract of land for a real estate developing company. Figures of cost are given.

Method and Cost of Constructing Wooden Forms for Concrete Manholes. By P. W. England. Eng.-Contr., Oct. 28, 1908; 2/3 p.

Describes construction of collapsible wooden form for concrete manhole and gives cost of work.

Concrete Structures from the Viewpoint of the Contracting Specialists. By DeWitt V. Moore, Con.-Engr., Oct. 2, 1908; 4 pp.

States the best work is generally done by the contract system. Considers the kind of man who enter the contract field; the effect of plans and specifications on the work, also discusses the responsibility for success and failure, and the kind of organization needed to carry on concrete construction. An article of interest to contractors.

Methods of Constructing Reinforced Concrete Highway Bridges in Ontario, with Some Figures on Cost. Eng.-Contr., Oct. 28, 1908; $1\frac{1}{4}$ pp.

The bridges are plain slab and slab and girder highway bridges, from 8 ft. to 40 ft. span. Specifications are given, general structure described, and costs of work are given. An interesting article to highway engineers.

Cost of Concrete Lining of Tunnel for South Canal, Belle Fourche Irrigation Project. Eng.-Contr., Oct. 14, 1908; $\frac{1}{4}$ p.

Gives itemized cost of lining 8x8 ft. tunnel, 1,396 ft. long, with 1-2 $\frac{1}{2}$ -5 concrete, including all charges except for surveys and designs. The costs are very fully itemized.

Reinforced Concrete Stone Bins and Trestle for the Street Department of Springfield, Mass. Eng.-Contr., Oct. 14, 1908; 1 p.

Shows general plans of bins and details of gates and wheel guards, and describes main structural features and methods of construction.

The Commercial Value of Fine Grinding of Portland Cement. By Ira A. Williams. Eng.-Contr., Oct. 11, 1908; 11/3 pp.

Gives summary of results of a very full set of tests made to determine effect of fine grinding on time of setting, soundness, strength, etc. Also discusses teachings of these results. A suggestive article.

Method and Cost of Constructing a Rubble Concrete Dam in the Central States. Eng.-Contr., Oct. 7, 1908; $1\frac{1}{2}$ pp.

Describes earthwork and concrete construction for a water power dam with a rubble concrete spillway section 490 ft. long and 4,300 ft. of earth embankment. Detail costs are given of camp, plant, materials and labor for both earthwork and concrete.

Method of Welding Reinforcing Rods for a Concrete Aqueduct by the Thermit Process. Eng.-Contr., Oct. 7, 1908; $\frac{1}{2}$ p.

Shows sections of test siphons for New York water supply, and describes method of welding circumferential reinforcing rings by the thermit process.

EARTH AND ROCK EXCAVATION.

The Cost of Excavating Earth in Small Quantities with a Steam Shovel. Eng.-Contr., Oct. 7, 1908; 2/3 p.

An example of using a steam shovel for excavating a daily output of 80 cu. yds. of earth, showing that it was more economical to do this with such a tool than by men with picks and shovels. Detailed costs are given.

Protection of Embankments from the Effect of High Water by Riprap or Otherwise. Proc. Asso. Ry. Supt. B. & E., October, 1908; 4 pp.

Report of committee having in charge investigations of this subject. Describes and illustrates several methods of protecting embankments with riprap.

Dredging for Platinum in the Urals, Russia. By L. Tovey. Eng. & Min. J., Oct. 10, 1908; 5 pp.

An account of the dredges used both for prospecting gravel and also dredging to mine the platinum. Illustrated with a number of photographs. Also describes the methods of dredging used.

Methods and Costs of Building Earthen Dikes on the Belle Fourche Project, and Comments on Spreading Earth. Eng.-Contr., Oct. 7, 1908; $2\frac{1}{2}$ pp.

A detail account of this work is given, and the cost of each item is shown, part of the work being done with steam shovels and cars and part with elevating graders and wagons. Comments of some length are made on the methods and cost of spreading earth on embankments.

The Cost of Excavating Gravel in a Canal with a 65-Ton Shovel. Eng.-Contr., Oct. 14, 1908; $\frac{3}{4}$ p.

An account of a month's steam shovel work on the Trent Canal in Canada. The cost in detail of the work is given. The output of the shovel was large, thus giving a low cost. The value of the plant is shown.

Reinforced Concrete

A Manual of Practice

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THIS book was written for the practical concrete worker—the man on the job—who has not the requirements of statics and the theories of the mathematician at his tongue's tip but who desires in plain words the fundamentals of correct design and the practice of sound and economical construction work.

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Some Records of Drilling and the Cost of Maintaining Drills. Eng.-Contr., Oct. 14, 1908; ½ p.

Some interesting records of machine drilling in tunnel work on the Reclamation Service are given, showing total number of feet drilled, feet drilled per shift, and also feet drilled per cubic yard of excavation. The cost of maintaining the drills used in the work is also given.

Method and Cost of Moving Earth and Loose Rock in Small Cars. Eng.-Contr., Oct. 14, 1908; ½ p.

An account of excavating and transporting 7,000 cu. yds. of earth and some boulders with small cars, giving the cost in detail of the work.

Hints on Machine Drilling and Blasting, and Data on Springing Holes in Tunnel Work. By George C. McFarlane. Eng.-Contr., Oct. 21, 1908; 1½ pp.

A very good paper on working in rock. Excellent hints are given on drilling, and some records of work done. A good method of sharpening bits and tempering is described. Springing holes in tunnel work is also commented upon, and some data on the subject given.

A Novel Pneumatic Dredge. Comp. Air, October, 1908; 3 pp.

Gives a description, supplemented by illustration, of a compressed air hydraulic dredge. The dredge is being used to pump sand from beneath a strata of clay that averages 28 ft. in thickness. The suction pipe is driven through the clay, and the sand pumped is discharged at as great a distance as 1,500 ft. from the machine.

Cost of Digging a Well or Cess Pool. Eng.-Contr., Oct. 28, 1908; ¼ p.

Gives the cost in detail of digging a well or cess pool 24 ft. deep, the earth being raised from the hole by a hand winch.

Method and Cost of Sinking a Winze with Long Holes. By George C. McFarlane. Eng.-Contr., Oct. 28, 1908; ½ p.

This article is reprinted from the "Engineering and Mining Journal." Gives an account of sinking a shaft by a novel method, and gives the cost of doing the work. The winze was sunk to ventilate a railroad tunnel. Long holes were drilled from the surface to the tunnel, and then the bottom of the holes shot, thus throwing the material into the tunnel. The blasting was repeated until the entire 30 ft. was shot down.

Stripping Reservoir Lands. By J. M. Diven. Engr.-Contr., Oct. 28, 1908; 2 pp.

Tells of a reservoir built at Elmira, N. Y., in 1871 and 1872, the entire area to be covered with water, having been stripped. Three years later the water began to have a pronounced odor and taste. This disappeared, then returned, and gradually grew worse, and has continued at intervals, always growing worse. A second reservoir is described at Charleston, S. C., where the ground covered with water was for the most part either rice land or swampy ground. At first trouble was had with algae, but each year the trouble has been less than the previous year, promising to continue to improve.

SURVEYING AND DRAFTING.

Traverse Surveying. By R. J. Williams. Surveyor, Oct. 16, 1908; 1 pp.

Gives methods for checking for errors in the measurement of a side or angle.

Leveling of Precision in the Panama Canal. Ry. & Eng. Rev., Oct. 10, 1908; 1 p.

Describes the exact leveling work recently done on the Panama Canal in establishing a permanent set of benches across the Isthmus, along the line of the canal and the Panama Railroad.

Home-Made Stadia Rod. By J. C. Black. Eng.-Contr., Oct. 14, 1908; ½ p.

Illustrates rod, describes method of construction and gives itemized cost.

The world's authority on this great subject.
The most expensive book ever issued and sold for \$5.00.

Concrete and Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; \$5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter—material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

Write for 16-page Table of Contents.

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The Technical League Has Secured One Hundred New Members and Has Held its First "Technical Talk."

In our issue of Aug. 26 announcement was made of the organization of the Technical League, a society having for its principal object the securing of adequate

salaries for engineers and other technical men.

We are informed by the Secretary of the Technical League that the number of members has already reached the century mark—the League has "gone to par."

The first "technical talk" was held in the 71st Regiment Armory recently. One of the objects of these talks is to "coach" the younger members of the League for civil service examinations.

Abuses of the civil service laws will come up for discussion at these meetings, and steps will be taken to rectify such abuses. The League will take an active part in future legislation affecting technical civil service employees.

There is certainly need for organized and intelligent effort on the part of engineers employed by cities and other governmental bodies in securing fair treatment and adequate compensation. To the average citizen a salary of \$1,500 a year appears "adequate" for an engineer's services. That this belief prevails is shown by the large number of city engineers who receive no greater salary than \$125 or \$150 a month, in spite of the fact that they control the expenditure of hundreds of thousands of dollars of the city's money.

It devolves upon some such organization as the Technical League to awaken the public to the fact that the most important public employees are its technical men. Today the city engineer, or the state engineer, is the tail of every political ticket, and, like other tails, about all that it gets from the public is a tin can.

May it not be possible that the Technical League will ultimately prove to the public that political graft can best be exterminated by placing technically trained men in all the important public offices. We believe that among no class of "public servants" is there so high a standard of morality as among engineers and men trained in the technical colleges of this country. There is, in truth, a whole code of morals in every book of science, for science is itself merely a record of truth.

We are requested by the Secretary of the Technical League to say that any inquiries as to membership in the League addressed to him at 721 Park Row Bldg., New York City, will receive prompt reply.

The Proposed Extension of the Chicago Drainage Canal as a Deep Waterway to the Illinois River.

One of the controlling ideas in the inception of the Chicago Drainage Canal was that it should ultimately form a link in a navigable waterway from the Great Lakes to the Gulf of Mexico. This idea has not only persisted during all the period that the Drainage Canal has been under construction and in operation, but it has grown stronger with the years. The problem is a large one and to enter into all its ramifica-

tions would be impossible in any space at our command. The fact remains, however, that for a distance of 25 miles across the divide that separates the waters of Lake Michigan from those of the Mississippi River there has been built a canal capable of carrying vessels of large size. Every consideration urges that the possibilities of this channel should be developed for navigation and all legitimate efforts to this end should be encouraged by engineers.

We make these statements now, because there is every reason short of absolute certainty to believe that the people of Illinois have voted in favor of beginning this long thought of waterway extension at once. At the elections of Nov. 3, in Illinois, one of the ballots called for a vote on a constitutional amendment permitting by action of the State Legislature the issuing of bonds not exceeding in amount \$20,000,000 to pay for a navigable waterway from Lockport, Ill., the present terminus of the Chicago Drainage Canal to the Illinois River. The conditions of this vote were that to pass, the amendment must have in its favor two-thirds of the total vote cast not merely on the amendment but for any purpose. This was an onerous burden for the proposition to carry and no surprise would have been felt if it had failed. Instead there is reasonable assurance that it succeeded. While the returns from some counties of the state are not complete the majorities in favor of the amendment in the counties heard from in full are such that there is small chance that the votes remaining to be reported can overcome them.

The vote in favor of the constitutional amendment is merely the initial step toward the proposed waterway. The State Legislature now has to legislate authorizing the issuance of bonds and defining the organization and methods by which the work shall be conducted. Nothing more definite than prophesy is to be had concerning such legislative action and there are prophets of disaster and prophets of success. Frankly, however, the sentiment seems to be strongly in favor of success, and success is boldly asserted by many of those in the best position to judge. It is at this point that engineers and contractors can use their influence to develop the proper sentiment, and we believe that they should do so.

The tentative plans as put forward by the Internal Improvement Commission are straightforward and clear. The commission itself is a capable one and has at least one member, Mr. Isham Randolph, M. Am., Soc. C. E., for years the chief engineer of the Chicago Drainage Canal whose opinion carries undisputable technical weight. There is every assurance that the Commission has given careful study to its work. Its figures show an unusually favorable financial outlook for the project as they are presented in the outline report so far made public (Eng.-Contr., Oct. 14, 1908.).

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Method and Cost of Constructing a Well by Sinking Reinforced Concrete Caisson Curbing.*

The increase in pumping from wells for irrigation water supply makes the following account of constructing a well for irrigation water supply of particular interest. This well is 24 ft. deep and 8 ft. interior diameter, and was built for the University of Arizona Agricultural Experiment Sta-

This construction is objectionable owing to the rapid decay of the curbing and to the difficulty of sinking the steel cylinder which has to be jacked down and often is distorted so that it cannot be driven further. The well described here was designed to overcome these faults and to give a cheap, durable construction that could be carried on by the labor and skill ordinary available. Its construction is shown by Fig. 1.

The concrete casing is circular and 8 ft.

rings near the bottom and above this point was wound spirally around the shell. The vertical spacing of the rings was about 1 ft. The concrete used was a 1-2½-5 mixture, allowing 3.8 cu. ft. per barrel of cement. Portland cement and local sand and gravel, hauled partly from a nearby stream until good material from the excavation was available, were used. The mixing and placing were done with especial care.

The casing was built in sections 3 ft. high, using the forms shown by Fig. 2, and was sunk as an open caisson by excavating inside. The bottom was provided with a shoe built of 2-in. plank sawed into segments and spiked together. This shoe was made 5 ins. wide on the bottom and the outer edge was bound with a small angle fastened by lag screws. It is thought that this blunt shoe enabled the sinking of the caisson to be much better controlled than would have a sharp cutting edge.

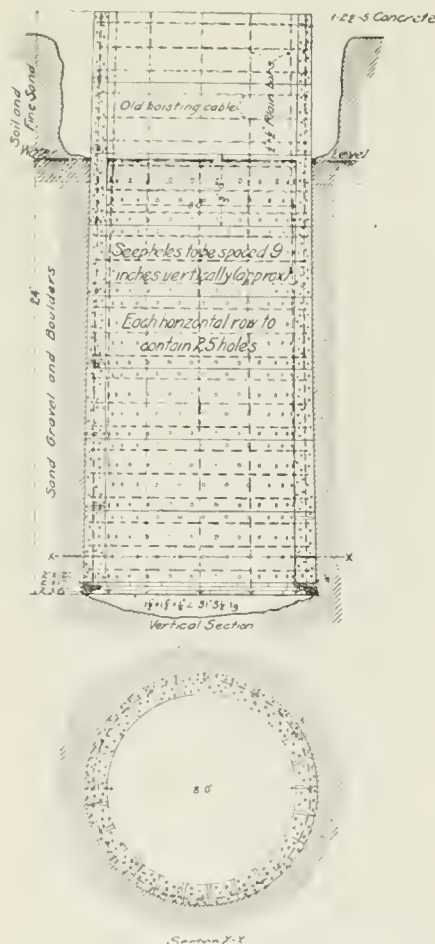


Fig. 1—Reinforced Concrete Curbing for an Irrigation Well.

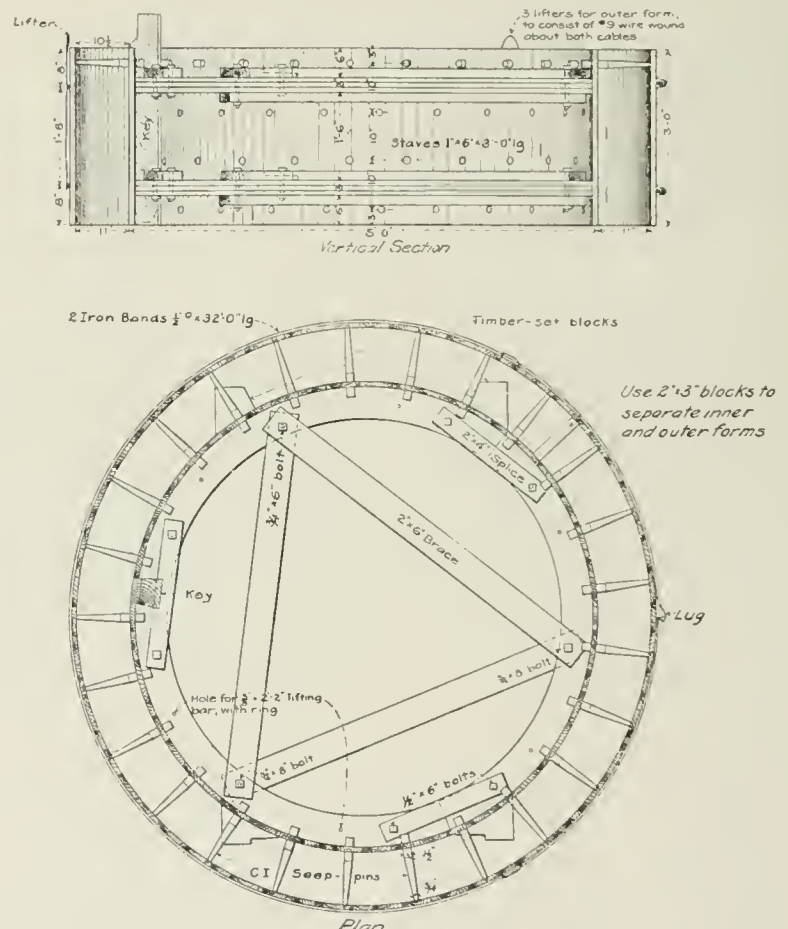


Fig. 2—Form for Constructing Reinforced Concrete Curbing.

tion after designs and under the direction of Prof. G. E. P. Smith, Irrigation Engineer. The usual practice in building such wells in Arizona has been to use a timber curbing down to water level and a small perforated cylinder of riveted boiler steel sunk from 6 ft. to 15 ft. into the water.

*Rewritten from a paper by Prof. G. E. P. Smith, University of Arizona, in "Cement Age," October, 1908, with the addition of cost data and further explanation of methods furnished us by Prof. Smith.

in diameter throughout; the shell is 11 ins. thick at the base, decreasing by an outside batter to 8 ins. at a height of 18 ft., and continuing 8 ins. thick to the top. The shell is reinforced with vertical plain square bars ½ in. in section, spaced 30 ins. apart, at the bottom, while higher up is some old scrap pipe and near the top a few Johnson bars. The horizontal reinforcement consists of worn out ¾ and ¾ in. hoisting cable. This cable was placed as separate

The construction of the forms is clearly shown by Fig. 2. It will be noted that cast iron taper pins thrust through the inside form and against the outside form were used to mold seep holes in the shell. These pins were withdrawn as soon as initial set had occurred, but the holes were corked to force all the water to enter under the cutting edge, as it was found that this aided the work of sinking. In sinking, the first three rings or sections

were molded and allowed to harden for eight weeks before sinking was begun. The remaining sections were molded as the sinking progressed.

The chief trouble in sinking came from the water, the flow of which was so great that a vertical No. 6 centrifugal pump had to be oversped to keep the pit clean, and at times the work had to be stopped on account of water. Many large boulders were encountered under the cutting edge, some 20 ins. across; they were undermined with long picks and brought into the well. The casing frequently got out of plumb, but was easily straightened by undermining the high side. The casing sank readily without being loaded.

In the following costs of the work no allowance is made for distillate and labor used in pumping, as these costs are considered to be more than offset by the value of the pumped water to the rancher. Neither is any allowance made for setting the permanent pump. Yaqui Indian laborers were employed under an intelligent and pains-taking foreman. There were 18.2 cu. yds.

Concreting eight times.....	43.00	2.35
Total	\$193.62	\$10.63
The wages paid and the gang employed were: 1 foreman, \$4.50; 1 Mexican, \$1.25; and 5 Yaquis, \$1. The following is a summary of the cost:		
40 per cent depreciation on forms...	\$	27.58
Shoe		29.68
Reinforcement		21.34
Sundry supplies.....		14.18
Concrete		193.62
Sinking, including setting No. 3½ pump		178.00
Sundry labor, jin pole, hauling, etc., about		80.00

Total	\$544.40
The cost of sinking was unduly high. The foreman had a seven mile drive every morning, and on his arrival at the well several hours were consumed on some days in getting the engine and pump in good running order and in pumping the water down so that the laborers could descend and excavate.	

Method and Cost of Constructing a Wooden King Post Truss Bridge with Concrete Abutments in Cuba.

BY CHARLES M. KERCHER,*

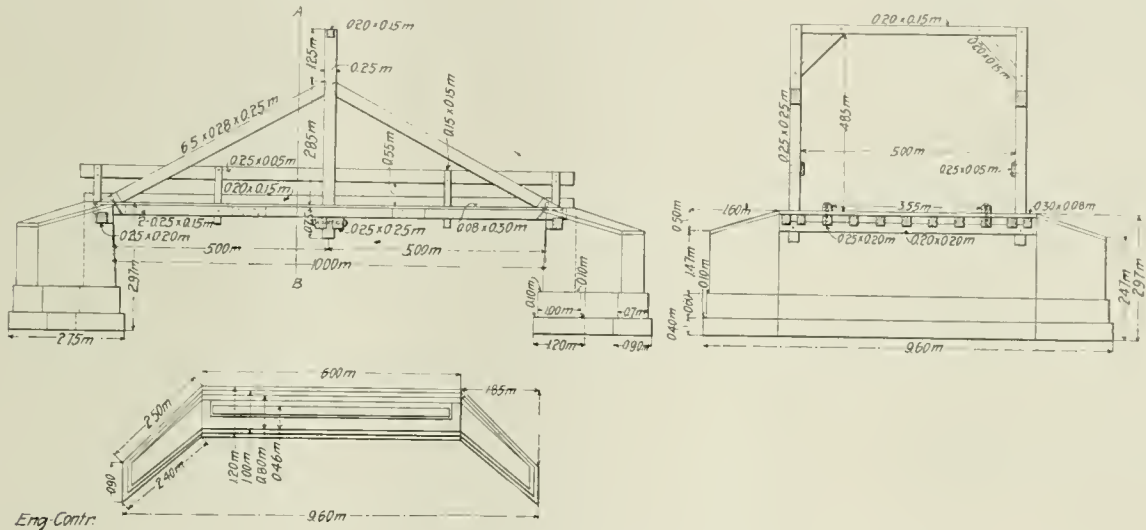
The bridge was a 10-meter or 32.81 ft. highway truss bridge something on the style of a King truss. The abutments are concrete and the bridge proper is built entirely of the hardwoods abounding plentifully in the district where it was built. The woods used were:

Acana; weight 81 lbs. per cu. ft., modulus of rupture 18,500 lbs., tensile strength 11,200 lbs.

Jucaro prieto; weight 67.3 lbs. per cu. ft., modulus of rupture 16,000 lbs., tensile strength 11,200 lbs.

Yaba roja; weight 75 lbs. per cu. ft., modulus of rupture 18,000 lbs., tensile strength 10,000 lbs.

The Yaba wood was used for flooring and the Acana and Jucaro prieto were used in the beams, stringers, etc. The form and dimensions of the bridge are



Form and Dimensions of Wooden King Post Truss Bridge.

of concrete in the casing. The costs were as follows:

Formwork, etc.:	Forms.	Shoe.
Lumber at \$50 per M. ft.....	\$22.50	\$ 7.50
Iron	5.45	11.43
Hoop lugs.....	2.00	..
Asphalt paint.....	1.25	..
Nails at 7 cts. per lb.....	1.25	0.75
61 cast iron taper pins.....	11.50	..
Carpenter at \$5 per day.....	25.00	10.00

Totals	\$68.95	\$29.68
As the forms were capable of being reused, the charge made against the work was 40 per cent depreciation, or \$27.58.		

The cost of the concrete in place was as follows:

Item.	Total.	Per Cu. Yd.
20½ bbls. cement at \$5.25....	\$107.62	\$5.91
Hauling, sand and gravel...	20.00	1.09
Setting forms eight times....	23.00	1.28

The foreman has since built and sunk a curb 10 ft. high from water level downward (the 30 ft. above water level is curbed with plank); contract price on the 10 ft. concrete curb was \$300. He bought new steel outside form at cost of \$40; also paid out \$186.55 and contributed 14 days of his own labor. He borrowed the inside forms used on this job and no charge was made for them.

On Oct. 22, according to the Canal Record, steam shovel 253, working at San Pablo, Canal Zone, loaded 313 10-yd. dump cars in 370 minutes, an average of one minute and eleven seconds per car. Assuming that the cars were loaded to their full capacity a cubic yard of material was placed on them every seven seconds. The only breaks in the day's work were occasioned by moving the shovel forward and cleaning the dipper.

shown by the accompanying drawings, so I will confine myself to the cost data.

The concrete was a 1—3—5 mixture, mixed by hand, and after being placed was well spaded and tamped. The cement used was Atlas Portland, which cost \$4.50 per bbl. at the work. The cost per cubic yard of materials was as follows:

1.13 bbl. of cement at \$4.50.....	\$5.08
0.80 cu. yd. crushed rock at \$2.85 per cu. yd.....	2.28
0.48 cu. yd. river sand at 20 cts. per cu. yd.....	.096

Total	\$7.456
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The excavation for the abutments was made in a good firm soil and was only of a sufficient depth to secure good foothold for the masonry. No solid rock could have been found without excavating over ten times the amount excavated. The excava-

*Apartado No. 7, Neuquitas, Cuba.

tion consisted of 65 cu. yds. of common excavation at \$0.594 per cu. yd., a total of \$38.61.

The cost of concrete, forms, etc., was as follows:

	Total Cost.	Cu. Yd.	Cost per
92 cu. yds. concrete.....	\$685.95		\$7.456
400 ft. B. M. lumber for forms at \$18 per M. ft..	7.20		0.078
Labor on forms, 2 carpen- ters 2 days at \$1.....	8.00		0.087
Mixing and placing 92 cu. yds. concrete.....	91.76		1.03
Total	\$795.91		\$8.651

The framing was carried on by a master carpenter and two assistants under the continual supervision of the inspector. The cost of timber, framing, etc., was as follows:

7,100 ft. B. M. hardwood timber at \$50	\$355.00
Framing timbers (1 carpenter \$2.50 per day, 2 assts. \$1.75 per day), 8 days, \$6.....	48.00
1,000 lbs. plates, bolts, spikes, etc., at 16 cts. per lb.....	160.00
Labor erecting, bolting, nailing, 5 men 6 days at \$1.50.....	45.00
Painting 1,000 sq. meters 2 coats red lead at 15 cts.....	150.00
Total	\$758.00

The painting was done by contract by a firm that has a contract the year round to paint all new structures. The summary of costs is as follows:

Excavation	\$ 38.61
Concrete	795.91
Bridge proper.....	614.00
Superintendence	137.85

Total cost\$1,730.00

This gives a cost per lineal meter of bridge of \$173.04, and a cost per lineal foot of bridge of \$52.76.

The Pennsylvania R. R. has awarded a contract to the Westinghouse Electric & Manufacturing Co., for materials and equipment for the electrification of the Pennsylvania terminals in the Boroughs of Manhattan and Queens, New York City. The contract amounts to about \$5,000,000, and includes an electrification of the system from Harrison, N. J., to Jamaica, L. I.

The Fifth Annual convention of the Northwestern Cement Products Association is to be held at Minneapolis, Minn., on March 2, 3, and 4, 1909. The convention will be held in the Armory of the Minnesota National Guard. Martin T. Roche, St. Paul, Minn., is president of the Northwestern Cement Products Association, and J. C. Van Doorn, Minneapolis, Minn., is secretary.

The value of the iron produced in the United States in 1907 was \$529,958,000.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Methods and Costs of Dredging the St. Lawrence River.

One of the great engineering works of America, which has been carried on for some decades, has been the dredging of the St. Lawrence River.

Description of Work.—The first improvement work was commenced in 1844, and has been continued with few interruptions ever since. The ship channel of the river, between Montreal and Father Point, where the river begins to widen out into the gulf of St. Lawrence, has a total length of about 340 statute miles. However, the contracted part of the river, which may properly be called ship channel, extends to the Traverse, to which point, from Montreal, the distance is 220 miles. The first work done on the river improvement in the '40's was only at some points in the channel of Lake St. Peter, where the water was very shallow, in order to allow vessels of 500 tons to reach Montreal.

In 1851 the Montreal harbor commissioners undertook the definite task of making a channel from Montreal to Quebec, a distance of 160 miles. From Montreal to Cap la Roche, a distance of 108 miles, the channel was improved from stage to stage, until in 1888 a depth was attained of 27½ ft. at ordinary low water, and from the last named place to Quebec, 27½ ft. at half tide. In 1888 the Department of Public Works took charge of the river improvement and continued it as a government work and made it free to the navigation of the world. At all times the work has been by dredges owned by the channel authorities and operated by day labor forces.

During the 38 years mentioned (1851-1888) the cost of the work for labor and supplies was 17.1 cts. per cu. yd., while there was expended for plant, shops, repairs, surveys, etc., 2.7 cts. per cu. yd., making a total cost of 19.8 cts. per cu. yd. for the 19,865,693 cu. yds. of material dredged.

From 1889 to June 30, 1899, the Department of Public Works continued the improvements, widening and cleaning up the channel to 27½ ft. at ordinary low tide, excavating during this period 3,558,733 cu. yds. at a cost for labor, supplies, etc., of 23.3 cts. and 14 cts. for plant, shops, repairs, surveys, etc., making a total cost per cubic yard of 37.3 cts.

In 1899 the department undertook the execution of a new project—namely: to dredge a channel between Montreal and the Traverse 30 ft. deep at the lowest water recorded in 1897, widening the channel to a minimum width, in the straight portions, of 450 ft. and on the curves from 500 to 750

ft. The length of the channel actually requiring improvement by dredging from Montreal to the Traverse is about 70 miles.

From 1899 to the end of the season of 1903-4 the work was done under the Department of Public Works, but at the end of that season the dredging was put in charge of the Department of Marine and Fisheries, Mr. F. W. Cowie, M. Can. Soc. C. E., being superintending engineer. At the end of the season of 1907 (March 31, 1908) the length of the 30 ft. channel actually completed was 58½ miles, leaving 11½ miles still to be dredged. The widening had been completed except for a distance of 9½ miles in the straight portions of Lake St. Peter. As the dredging is completed the channel is swept, with the result that the depths dredged are reliable and available. The non-tidal work was all completed and by the aid of the tide, from Cap la Roche to Quebec, a depth of 30 ft. of water could be obtained from the sea to Montreal in November, 1906. In all, 55,517,055 cu. yds. of material have been excavated to date.

The work yet to be done consists in obtaining the standard width in Lake St. Peter and the tidal parts of the river, and obtaining the full depth of 30 ft. below low water of 1897. There still remain to be excavated 13,000,000 cu. yds. Thus the total amount of work done and to be done is over 68,500,000 cu. yds., an undertaking of no mean size.

Conditions Surrounding the Work.—It is probable that there is no river in the world better adapted for improvement than the St. Lawrence. The great lakes act as storage reservoirs and settling basins for the river. Except for floods during the ice accumulations, the fluctuations in level are gradual and not excessive. The position of the St. Lawrence is the reverse of most rivers. The ordinary river has steep slopes near the source, which cause erosion of the banks and transportation of the coarse material, which, as the slope becomes more gradual, decreases until, at the mouth of the river, the water in the comparatively slack current deposits the fine sediment to the great detriment of navigation.

In the St. Lawrence the material from most of the sources of supply is all deposited in the settling basins. Even the streams that flow directly into the river, carrying a certain amount of material in suspension in their waters, find natural settling basins along the shores of the St. Lawrence itself, where the river widens into the so called lakes and bays, as Lake St. Peter. From the great lakes to the ocean the bottom of the river is usually hard, so that there is not only clear water, but a perma-

ment river bed. The nature of the material composing the bottom of the river, though in many places very difficult to dredge, is for the same reason of such a character that a dredged cut, once made, is substantially permanent.

The currents of the St. Lawrence are, for a river of its size, not only reasonable and regular, but altogether free from the usual dangers to navigation resulting from freshets. The water at times is hard, and sudden squalls occur, when dredges have to suspend work and frequently seek sheltered places. Between Quebec and Montreal the river is usually free from ice about April 10, and is closed to traffic about November 25, making the season of navigation about 7½ months, during which time all the dredging has to be done. The only troublesome period of flood is when the ice breaks up in the spring.

The dredging operations do not theoretically or practically lower the level of the water in the river. No material is removed; it is merely taken from one place and deposited in another.

Materials Excavated.—The materials excavated vary from soft blue clay into which a pole may be planted some 6 or 7 ft. by hand, to stiff clay, to hard pan as hard as a macadam road, to shale rock and to large boulders. The material is increasing in hardness from year to year, as the work goes deeper and nears Quebec. Nearly all the soft material, except the remainder of the work in Lake St. Peter, is now completed. A dredge that can move 6,000 cu. yds. of soft material in a day has to work much harder in dredging 1,000 cu. yds. of hard pan in which boulders are imbedded.

In one or two localities coarse sand occurs, at which points dredging has, to some extent, to be repeated. Below Quebec at the localities where the fresh and salt waters meet, there are the usual sand bars. The best information goes to show that these shoals are not increasing. As the size and draught of ships increase, as well as the competition in speed, detention while waiting for the tide, to pass these bars, is more apparent. The movable nature of this material, added to the lack of uniformity of the tides, currents and salt water, results in instability in these shoals. It is therefore expected that the maintenance of the excavated channels there will require some annual redredging.

Outfits Used.—The first dredging machinery used was built in Glasgow, Scotland. Since 1844, with but few exceptions, all dredges, machines, etc., have been designed and built in Canada. The progress made in dredge construction and operation since 1844 is phenomenal, and is strikingly shown by the work done with different machines used on the river during the past 60 years. A dredge in 1846 excavated in Lake St. Peter in one day about 1,200 cu. yds. By wonderful improvement to plant, in 1888 a dredge excavated 7,200 cu. yds. without trouble, while in 1906, working day and

night, 20,000 cu. yds. were a frequent day's work.

The plant at work during the season of 1907 was as follows:

6 elevator dredges.

1 hydraulic dredge with 23 double pontoons floating a 2,300 ft. double line of pipe and 2 winch scows.

1 twin screw self containing hydraulic dredge.

1 twin screw sea going pump dredge.

1 ice breaking and sweeping tug and 1 testing or sounding scow used with it.

1 inspection tug.

11 tugs for serving dredges.

4 coal barges.

1 coal scow.

2 stone lifters.

6 lodging scows.

14 hopper scows.

The six elevator dredges were built between the years 1891 and 1902, one being built in 1894, one in 1897, two in 1900, one in 1901 and one in 1902. They are from 148 to 168 ft. in length; have beams of 30 to 34 ft.; depth of hold from 13 to 14 ft.; have average draught from 8 to 11 ft.; have greatest working depth from 42.5 to 45 ft.; buckets of capacities up to 1 cu. yd., and can excavate from 1,000 to 3,500 cu. yds. of fairly hard materials per day. The two built in 1900 have steel hulls, the rest have wooden hulls. These dredges have earned a good reputation for themselves. They have all been designed and built at the Sorel yards of the Canadian government. They are built massive in strength, with good material and careful workmanship. They are not competitive construction, neither are they cheap.

Considering the hard character of the material, the strong current and the fact that the work must be carried on without interrupting navigation and the making of a smooth bottom, the elevator dredge has done magnificent work. A powerful dipper dredge may tear up a certain quantity of soft rock more quickly, without stopping to make a clean, even bottom, and chisel cutters and blasting plants may break up harder material, but the elevator type of dredge does good clean work without interrupting navigation. However, the constant, steady work in exceedingly hard material, at a depth of from 32 to 42 ft., is hard on machinery. Only the best machinery can stand it. The dredges, when taken into winter quarters in November, 1907, showed broken teeth and twisted buckets. The dredge "La Fontaine," built in 1901, had a complete new set of solid steel rock buckets put in her at the end of the season of 1905, the old ones being used up in about three seasons' work. The dredge "Baldwin" at the same time had her buckets rebuilt. This dredge was built in 1902, so only two seasons of work were done with the buckets before it was necessary to rebuild them for work in harder material. On the four other dredges some new buckets, tumblers, teeth and other parts had to be furnished. The total cost for the season of renewals and repairs on

buckets preparatory to commencing work in rock at Cap a la Roche was \$71,826 12. This makes an average of nearly \$20,000 per dredge for new sets of buckets. During the season of 1906 the "Laurier," built in 1897, had new ¾ cu. yd. buckets put in her for digging in hardpan, at a cost of \$19,336.

The hydraulic dredge used on the St. Lawrence is the well known dredge, "J. Israel Tarte," designed by Mr. A. W. Robinson. This dredge was built to aid in the dredging of Lake St. Peter, and the following conditions were considered in her design and building:*

"(1) It must be able to make a cut 700 ft. wide at one time and 5 ft. to 10 ft. thick at one cut.

(2) It must have a clean and level bottom and cut mechanically the entire area, as the material is blue clay and will not run or wash like sand.

(3) It must deliver the material sufficiently far to one side of the channel to avoid any risk of washing back again.

(4) The floating pipe line must be so arranged that it will freely permit of the movements of the dredge, and that it will withstand the winds and waves due to the locality, and which are severe at times.

(5) The dredge must be so worked that it will not obstruct the channel for passing ships.

(6) The anchorage and movements of the dredge must be so arranged that the feed will be continuous and uniform.

(7) The capacity to be a working rate of 2,000 cu. yds. per hour.

(8) The dredge must have ample coal supply and provision for a double crew."

The dredge was built to meet these requirements by the Polson Iron Works of Toronto, Ont., and was delivered and tested in 1901, but she was not put to work until the season of 1902. The contract price for this dredge was \$163,800, but this did not include the discharge pipe or winches or alterations found necessary. Prior to the building of this dredge the work done in Lake St. Peter had been by the elevator dredges.

In 1886 a dredge had excavated 886,710 cu. yds. for \$25,723, or a cost per cubic yard for labor, coal, etc., of 2.9 cts. In 1901 the "Lady Aberdeen" with 1 cu. yd. buckets excavated 120,600 cu. yds. in 21 days at a cost of \$3,054.88, or a unit cost of 2.53 cts. The actual working time was 246 hours, making an output per hour of 490 cu. yds. The material in Lake St. Peter is a soft blue clay that stands up straight when excavated, not being easily washed by the water.

When the "Tarte" was put to work in June, 1902, she excavated 93,750 cu. yds. This was done in 41¼ hours. The month's output rapidly increased as the men became accustomed to their new work. In September 580,000 cu. yds. were dredged, in October 600,000 cu. yds. The length of the channel deepened in September was 7,800

*Extracted from a paper read by Mr. A. W. Robinson before the Canadian Society of Civil Engineers.

lin. ft., 325 ft. wide by 5 ft. average thickness cut, while in October 8,000 lin. ft. were deepened. In 1903 126 working days showed an excavation of 2,671,750 cu. yds. scow measurement, equal to 21,200 cu. yds. per day. In the month of September, 1903, there were excavated 757,100 cu. yds. This was done in 25 work days or 552 working hours, making an average rate of 1,616 cu. yds. per hour, or 30,280 cu. yds. per day. During the season of 1901, in 92 days the machine dredged 1,123,125 cu. yds. at a cost of \$79,302.02, or an average of 7.96 cts. per cu. yd. During 1905 the total number of cubic yards removed amounted to 1,984,510 at a cost of \$117,668.03, or an average of 5.92 cts. per cu. yd. The dredge worked 160 days. During 1906 the dredge worked 105 days, excavating 1,358,560 cu. yds. at a cost of \$86,533.82, or 6.36 cts. per cu. yd. The dredge, including hull, machinery and a 5 ft. pipe line, as altered and improved, now stands about \$100,000 complete.

The "Tarte" is 160 ft. long with 42 ft. breadth of beam and an average draught of 6 ft. The length of the suction frame is 80 ft., the greatest working depth being 15 ft. The discharge pipe is 36 ins. in diameter. There are 4 marine boilers adapted for a working pressure of 160 lbs. The engines are triple expansion marine type having cylinders 20, 31 and 50 ins. in diameter by 25 ins. stroke. The rotary cutter is 9 ft. 6 ins. in diameter by 9 ft. long, weighing 10 tons. The cutter has 4 steel cutting blades at the apex and 8 at the throat. These blades are so designed that the clay cannot clog up the throat. The cutter is driven by a pair of engines of the double tandem type of 300 H. P.

Near the close of the season of 1903 one of the locomotive type boilers exploded, causing the loss of two lives and injuring the dredge; \$4,000 was paid to the heirs of one of the men. The dredge was laid up some months for repairs and 4 new marine boilers were put in her. The installation of the boilers, a new system of steam piping, the erecting of the smoke stacks and the work on the cabin cost \$27,611.11. At the end of the working season of 1905 the boilers were overhauled and repaired, as were nearly all parts of the dredging machinery.

During July, 1905, several days were lost by the cutter head of the "Tarte" breaking off, and, in September, 1905, the cutter shaft broke. In five working seasons the repairs caused by explosion of the boilers, and by the work of the dredge, have averaged from \$8,000 to \$20,000 per season, or a little over 5 per cent of the cost of the machine per year.

The repairs on an elevating dredge and its accompanying outfit likewise average about \$10,000 per year. It costs about \$10,000 per year to operate such a dredge and its accompanying outfit, and over twice that amount to operate a hydraulic dredge. The entire plant on this St. Lawrence work cost, as nearly as we can estimate, about \$2,000,000.

In 1906 it was decided to put at work a

self loading hopper dredge, or, as it is sometimes called, a self containing dredge, in the channel below Quebec. It was decided to buy a second hand machine, as quick delivery could not be obtained on a new machine, and it was not desirable to wait until one could be built. Such a machine was located for sale in New Orleans, La., and was purchased for \$116,000. It was brought to Quebec in 29 days and all the expenses of the long trip—namely: docking, repairing, wages, provisions, stores, etc.—amounted to \$10,942.11. The insurance was \$1,571.17.

This dredge, called the "Galveston," is 233 ft. long, breadth 39 ft., draught when loaded with 1,800 tons 11 ft. 9 ins. The machine dredges to 55 ft. and raises 1,350 cu. yds. in 45 minutes. The hopper capacity is 1,400 cu. yds. The machine was built in 1904. It is equipped with two 600 H. P. engines. Another new dredge, the "Beaujeu," the largest dredge in Canada, has since been added to the fleet below Quebec.

The department maintains a well equipped shop at Sorel for both building and repairing dredges, tug boats, scows and other necessary things needed in the work. It also has a repair shop mounted on a scow for making field repairs. This shop also does work on other dredging fleets owned by the Canadian government.

Crews and Wages.—About 500 men are employed in connection with the dredging operations. These men, all sailors, were born and brought up at Sorel or at some of the parishes bordering on the St. Lawrence River. Most of them have been trained to the service from boyhood. The senior captain of the fleet makes the statement that he has never earned a cent in any other service. A great deal of the success of the operations is due to this good training. The work requires extraordinary care and great patience, the machinery being forced to the utmost, and the passing of vessels requires continual watching.

A captain and an engineer are in general charge respectively of the vessel and machinery. The remainder of the crew is divided into two watches, and works in shifts of 6 hours on and 6 hours off. Work is carried on from midnight Sunday until noon Saturday, making 132 hours per week. Only two holidays, Dominion day and Labor day, are given throughout the season. The boarding of the men is done by contract with the captain of the vessel, at so much per man. Most of the dredges and tugs are fitted up with lodging accommodations for the crews, but in addition to this, extra men are cared for on the six lodging scows that are carried with the dredging fleet.

The following crew is used on the elevator dredges and the men are paid the monthly salaries shown:

1 captain.....	\$80
1 engineer.....	90
4 officers.....	\$10 to 65
2 engineers.....	40 to 60
10 sailors.....	28
6 firemen.....	30

1 watchman.....	28
3 women cooks.....	12 to 18

The following crew is worked on a hydraulic dredge the monthly salaries paid being as follows:

1 captain.....	\$100
1 engineer.....	105
4 officers.....	\$50 to 75
2 engineers.....	55 to 70
2 scow men and carpenters.....	50
12 sailors.....	28
6 firemen.....	32
2 greasers.....	40
1 watchman.....	28
4 women cooks.....	12 to 18

In addition to these wages the men receive their board free.

The crews of the tugs are paid somewhat similar salaries, and have good pilots and large crews to handle the heavy scows in the current and during sudden squalls. During the closed season only enough engineers and firemen are retained to look after the boats.

Methods of Dredging.—The channel, for the purpose of organization and details, has been divided into five divisions. To a great extent, outside of the "Galveston" and the "J. Israel Tarte," the dredges have not been worked continually in the same divisions, but have been assigned to work according to the class of material to be excavated, or according to the urgency of the work. The dredge "Tarte" has worked exclusively in Lake St. Peter and the "Galveston" in the channel below Quebec. The dredges are operated continuously. Stops are made only for repairs, for shifting from one place to another, bad weather or to give room for passing vessels. Coal is supplied by barges without stopping the work.

The elevator dredges discharge the excavated material through a chute into scows, one tug with two scows and a spare scow serving each dredge for this purpose. The average distance the material is hauled is a little less than a mile. The small wooden barges hold 300 cu. yds. each, and it takes a barge 15 minutes to haul one of these away, dump it and return. Thus with small barges and one tug it is possible to carry away 1,200 cu. yds. in an hour—more material than the dredge is likely to excavate. These dredges are anchored by a long bow cable and two side cables on each side, thus permitting the dredge to make a wide radial cut; likewise to clear readily for passing boats.

The "J. Israel Tarte" is held also by a stern cable and works in the same manner from one side of the channel to the other. In order to allow vessels to pass, the dredge takes one side of the channel and allows the anchor lines on the side of the passing vessel to drop to the bottom of the channel by paying out slack.

The discharge pipe, of which there is about 2,600 ft., has ball and socket spring joints every 100 ft. The pontoons are about 100 ft. long, being built of two cylindrical air chambers, with the discharge pipe held between them. The discharge end of the

pipe is held to place by a winch scow. When the dredge is working on the side of the channel on which the discharge pipe is laid, the pipe floats on the water in a decided curve. As the dredge works to the other side of the channel, the line of pipe straightens out, only changing the position of the outlet end of the pipe slightly.

Both style of dredges work to a uniform bottom, cleaning it up as they go. Where boulders are encountered, the stone lifting boats are called into service. These boats are equipped with grips capable of lifting boulders weighing 50 tons. When the cutter head of the "Tarte" came off, it was recovered with one of these stone lifters.

After the dredging work is done the channel is swept for lumps or boulders that may have been left. This work is now done with the large ice breaking tug, on which is

The total yardage dredged each season, the total cost and the cost per cubic yard are given in Table I.

During the first four years the work was done entirely by elevating dredges, the largest amount being excavated and at the lowest cost during the season of 1902-3. Each one of the elevating dredges during that season averaged more than 1,000,000 cu. yds. of excavation. During the last four years the work done includes that done by the two hydraulic dredges, the first three years having been the work of the "Tarte" alone, while the last year also includes some work done by the "Galveston." Consequently these costs are average costs of

ing the character of the material excavated, total cost, cost per cubic yard, number of days worked per season and the percentage of the hours actually worked of these days. The season is generally from 185 to 190 days long. The two last columns show the number of days lost in repairs, etc., and also the time lost by bad weather, moving, clearing traffic and other delays. It will be noticed that these dredges during three seasons have not averaged more than 55 per cent of their time in actual work.

The total cost given for each season's work for each dredge in Table II is divided into the various items in Tables III, IV and V. The fuel, wages and board of men are

TABLE I.

Year.	No. of cu. yds. (scow measure.)	Wages, Supplies, etc.	New Plant, Rebuilding, Shop, Surveys, etc.	Cost per cu. yd. Wages, Supplies, etc.
1899-1900	1,107,894	\$100,191.01	\$265,270.78	\$0.090
1900-1901	2,479,385	136,680.83	287,040.04	0.055
1901-1902	3,098,350	185,429.80	479,731.47	0.060
1902-1903	6,544,605	255,776.55	277,703.50	0.040
1903-1904	4,619,260	276,958.59	308,765.44	0.060
1904-1905	2,716,220	311,087.93	266,460.33	0.115
1905-1906	4,047,530	431,768.30	125,107.37	0.106
1906-1907	3,001,010	302,677.37	80,613.26	0.102

maintained a testing plant. The work has to be done with great care and under good weather conditions. In addition to this the dredged and shallow channels are being swept once a year.

The Cost of the Work.—In making up the cost of the work of dredging, everything is included, except interest on the capital expenditure and depreciation. The principal items of cost are wages, fuel, board, stores and repairs, as well as general expenses and superintendence. The item of repairs includes keeping the plant in constant good order, but not new or improved machinery.

the season's work, and as stated they do not include interest and depreciation on the capital invested. The item of plant, ships and surveys are the costs of those things and are charged directly to the work. In the cost given of the work the repair charges are included.

In Table II we give the work done by each of the seven dredges used during the seasons of 1904-5, 1905-6 and 1906-7, show-

ing the character of the material excavated, the cost of stores and materials, the labor and materials used in repairs and the proportional part of general and office expenses. The cost of the stone lifter service is divided among the six elevator dredges and the tug service to each dredge is given. As a rule one tug serves an elevator dredge, while two serve the "J. Israel Tarte," although at times two tugs are needed with the elevator dredges. The cost of the tug

TABLE II.

Season.	Material.	No. cu. yds.	Total Cost.	Cost per cu. yd.	No. days actual work.	Percentage of days actual work.
Dredge No. 1, "Laval"—						
1904-1905	Clay and boulders	215,925	\$39,027.20	18.07	173	63
1905-1906	Clay and stones	144,000	50,828.47	35.29	185	62
1906-1907	Clay and stones	161,550	38,596.98	23.89	121	63
Dredge No. 2, "Laurier"—						
1904-1905	Clay and boulders	149,750	\$11,271.36	27.56	165	52
1905-1906	Clay and sand	408,350	49,255.65	12.06	185	63
1907-1908	Clay and stones	130,300	32,199.71	24.71	121	69
Dredge No. 3, "Lady Aberdeen"—						
1904-1905	Hardpan	295,400	\$39,163.00	13.25	181	64
1905-1906	Hardpan boulders	270,700	46,886.99	17.32	180	70
1906-1907	Clay, sand, stones	256,900	32,059.41	12.47	124	67
Dredge No. 4, "Lady Minto"—						
1904-1905	Hardpan	56,000	\$25,409.25	45.21	59	65
1905-1906	Clay and boulders	278,650	50,739.82	18.20	184	66
1906-1907	Clay and boulders	412,400	33,463.27	8.11	121	75
Dredge No. 5, "Lafontaine"—						
1904-1905	Hardpan, boulders	571,000	\$44,237.71	7.70	181	61
1905-1906	Hardpan, boulders	213,600	55,736.39	26.09	185	71
1906-1907	Hardpan, clay shale	161,400	42,159.23	26.12	121	67
Dredge No. 6, "Baldwin"—						
1904-1905	Hardpan, boulders	301,820	\$42,677.59	14.14	172	67
1905-1906	Clay	747,720	55,640.95	7.44	186	74
1906-1907	Clay and stones	519,900	37,664.95	7.24	127	67
Dredge No. 7, "J. Israel Tarte"—						
1904-1905	Soft mud	1,123,125	\$ 79,302.02	7.06	92	57
1905-1906	Soft mud	1,984,510	117,668.03	5.92	160	56
1906-1907	Soft mud	1,358,560	86,533.82	6.36	105	54

TABLE III.—ITEMIZED COST OF DREDGE WORK FOR SEASON OF 1904-1905.

Dredges.	Fuel.	Wages.	Board.	Stores and Materials.	Repairs and Labor.	Proportion Gen'l and Office Ex.	Stone Lifter Service.	Tug Service.	Inspection, Towing, Sweeping.
"Laval" (No. 1).....	\$ 6,826.68	\$6,619.60	\$2,576.34	\$1,198.77	\$4,752.56	\$1,927.00	\$805.08	\$ 8,987.12	\$5,334.05
"Laurier" (No. 2).....	4,818.69	6,599.30	2,349.22	1,211.93	7,330.01	2,300.00	805.09	10,523.07	5,334.05
"Lady Aberdeen" (No. 3).....	6,023.88	6,928.41	2,612.74	1,408.22	4,204.59	2,018.00	805.08	9,828.03	5,334.05
"Lady Minto" (No. 4).....	2,268.14	2,527.87	802.15	1,273.72	6,055.62	1,932.00	805.08	4,410.43	5,334.04
"Lafontaine" (No. 5).....	8,226.70	6,883.49	2,671.07	1,502.04	6,303.15	2,294.00	805.09	11,618.12	5,334.04
"Baldwin" (No. 6).....	6,691.94	6,703.95	2,608.77	757.49	9,956.00	2,189.00	805.09	7,631.30	5,334.05
"J. Israel Tarte" (No. 7).....	18,026.59	19,799.14	3,337.80	2,207.02	4,437.23	3,508.00		17,018.16	10,668.08

TABLE IV.—ITEMIZED COST OF DREDGE WORK FOR SEASON OF 1905-1906.

Dredges.	Fuel.	Wages.	Board.	Stores and Materials.	Repairs and Labor.	Proportion Gen'l and Office Ex.	Stone Lifter Service.	Tug Service.	Inspection, Towing, Sweeping.
"Laval" (No. 1).....	\$ 7,192.94	\$7,254.12	\$2,570.62	\$1,791.19	\$11,670.10	\$5,272.78	\$640.39	\$ 8,008.35	\$4,427.98
"Laurier" (No. 2).....	6,271.74	7,097.96	2,575.35	2,223.06	9,248.50	4,712.08	640.39	10,058.56	6,427.99
"Lady Aberdeen" (No. 3).....	6,974.38	5,942.18	2,507.83	2,150.56	8,096.56	4,391.28	640.39	9,755.83	6,427.98
"Lady Minto" (No. 4).....	5,985.04	7,084.09	2,542.98	2,388.97	11,666.02	5,125.71	640.38	8,788.65	6,427.98
"Lafontaine" (No. 5).....	8,256.82	6,109.65	2,586.54	2,174.85	11,675.55	5,334.54	640.38	12,530.06	6,427.99
"Baldwin" (No. 6).....	7,235.24	7,124.08	2,554.09	2,012.25	12,400.19	5,430.57	640.38	11,816.17	6,427.98
"J. Israel Tarte" (No. 7).....	30,124.05	13,469.94	4,209.93	10,693.73	16,041.76	12,873.55		17,376.09	12,855.93

TABLE V.—ITEMIZED COST OF DREDGE WORK FOR SEASON OF 1906-1907.

Dredges.	Fuel.	Wages.	Board.	Stores and Materials.	Repairs and Labor.	Proportion Gen'l and Office Ex.	Stone Lifter Service.	Tug Service.	Inspection, Towing, Sweeping.
"Laval" (No. 1).....	\$ 4,398.80	\$5,050.30	\$1,804.54	\$ 506.70	\$10,356.16	\$4,203.97	\$365.20	\$6,795.20	\$4,716.12
"Laurier" (No. 2).....	3,632.55	4,977.68	1,742.01	1,455.64	4,735.48	3,089.23	365.19	7,485.81	4,716.12
"Lady Aberdeen" (No. 3).....	4,053.80	5,084.43	1,850.58	662.10	5,846.78	3,267.78	365.20	6,212.62	4,716.12
"Lady Minto" (No. 4).....	3,914.05	4,862.22	1,751.79	1,123.91	6,137.92	3,321.25	365.19	7,270.82	4,716.12
"Lafontaine" (No. 5).....	4,964.56	4,837.01	1,810.57	2,061.15	10,364.95	4,489.38	365.20	8,550.29	4,716.12
"Baldwin" (No. 6).....	4,810.06	4,953.83	1,809.53	676.35	7,761.46	3,737.30	365.20	8,835.10	4,716.12
"J. Israel Tarte" (No. 7).....	25,423.48	9,522.72	3,125.70	3,174.12	13,512.90	10,226.20		12,110.37	9,432.24

service could be divided under the first six headings given in the table. The cost of inspecting, towing of dredges and sweeping of the channel is shown in the last column. The suction dredge is charged just double the amount of the other dredges in making the distribution for the last named item.

In Table VI the cost per cubic yard for each item given in Tables III, IV and V is shown, and also the total cost per cubic yard. A wide variation in unit prices is shown here. The cost of fuel is in most cases as large an item as wages, exclusive of board for the men. The item of labor on repairs is also large. The charge for tugs is from about 15 to 25 per cent. As the dredge "J. Israel Tarte" only works in soft material, there is no charge for the stone lifter against it. The general and office expense does not exceed 10 per cent of the total cost. The inspection, towing and sweeping are a large item.

The wages paid on this work are quite low and long hours are worked. With only two shifts 24 hours are worked. If this

that an increased depth of water is needed, the work of this fleet of dredges is likely to be continued for some years to come.

This article has been written from data furnished this journal by Mr. F. W. Cowie, superintending engineer, now chief engineer of the Montreal Harbor Commission, and from reports made by him to the Department of Marine and Fisheries.

The Cost of Grading Two Hundred Miles or Railroad.

Mr. George C. McFarlane, in an article on the Building of the New Canadian Trans-Continental Railroad, gives, in Engineering Magazine, the following costs on building a section of this railroad.

As most of our readers know, this 3,400 miles of new railroad is being built jointly by the Canadian government and the Grand Trunk Pacific. The eastern division, 1,770 miles, extending from the Atlantic Ocean to Winnipeg, is being built by the Dominion government, and will be leased to the rail-

road prices paid station men, which is also approximately what it costs to take out the cuts with day gangs, the work will cost the contractors for labor and supplies \$8,250,000. Besides this the camps and roads cost \$600,000 to build; the horses, cars, rails, derricks, drills, and miscellaneous equipment represent an initial investment of \$1,345,000; as all kinds of contractor's equipment depreciate very rapidly, it is probable that all the contractor's plant will not be worth over \$600,000; of this the horses will be the principal item. The contractor's administration expenses, which include the salaries of general foreman, walking bosses, time clerks and clerks in the main offices, will amount to \$675,000. This makes the total cost to the contractors for executing \$11,000,000 worth of rock excavation \$10,270,000, leaving a profit of \$730,000 or 6.6 per cent. It is thought the profit made on supplies and clothing sold to the men would pay the interest on the cash bond furnished by the contractor, indemnity insurance and incidentals.

TABLE VI.—ITEMIZED COST PER CUBIC YARD OF DREDGING FOR THREE SEASONS.

Dredges and Seasons.	Fuel.	Wages.	Board.	Stores and Materials.	Repairs and Labor.	Gen'l and Office Ex.	Stone Lifter Service.	Tug Service.	Inspection, Towing, Sweeping.	Total.
"Laval" (No. 1)—										
1904-1905.....	\$0.031	\$0.030	\$0.012	\$0.006	\$0.022	\$0.009	\$0.004	\$0.042	\$0.025	\$0.181
1905-1906.....	0.050	0.050	0.018	0.013	0.080	0.037	0.005	0.055	0.045	0.353
1906-1907.....	0.027	0.031	0.011	0.005	0.064	0.027	0.002	0.042	0.030	0.239
"Laurier" (No. 2)—										
1904-1905.....	0.032	0.043	0.015	0.009	0.049	0.015	0.005	0.070	0.038	0.276
1905-1906.....	0.015	0.018	0.005	0.005	0.022	0.012	0.002	0.025	0.015	0.120
1906-1907.....	0.028	0.038	0.013	0.011	0.036	0.024	0.003	0.058	0.036	0.247
"Lady Aberdeen" (No. 3)—										
1904-1905.....	0.020	0.024	0.009	0.005	0.014	0.007	0.003	0.033	0.018	0.133
1905-1906.....	0.025	0.022	0.010	0.008	0.029	0.016	0.002	0.036	0.025	0.173
1906-1907.....	0.016	0.021	0.007	0.002	0.023	0.012	0.001	0.024	0.018	0.124
"Lady Minto" (No. 4)—										
1904-1905.....	0.040	0.045	0.014	0.022	0.108	0.034	0.014	0.080	0.095	0.452
1905-1906.....	0.021	0.026	0.009	0.008	0.042	0.029	0.003	0.031	0.023	0.182
1906-1907.....	0.010	0.012	0.004	0.003	0.015	0.008	0.001	0.017	0.011	0.081
"La fontaine" (No. 5)—										
1904-1905.....	0.012	0.012	0.005	0.001	0.018	0.004	0.001	0.014	0.010	0.077
1905-1906.....	0.039	0.029	0.012	0.010	0.054	0.024	0.003	0.060	0.030	0.261
1906-1907.....	0.031	0.030	0.010	0.013	0.064	0.028	0.002	0.053	0.030	0.261
"Baldwin" (No. 6)—										
1904-1905.....	0.022	0.022	0.009	0.003	0.033	0.007	0.003	0.025	0.017	0.141
1905-1906.....	0.009	0.009	0.003	0.003	0.017	0.007	0.001	0.016	0.009	0.740
1906-1907.....	0.009	0.010	0.003	0.001	0.015	0.007	0.001	0.017	0.009	0.720
"J. Israel Tarte" (No. 7)—										
1904-1905.....	0.016	0.017	0.003	0.002	0.004	0.003		0.015	0.010	0.070
1905-1906.....	0.015	0.006	0.002	0.005	0.008	0.007		0.009	0.007	0.059
1906-1907.....	0.019	0.007	0.002	0.002	0.010	0.008		0.009	0.007	0.064

work was being done by or for the U. S. government three shifts would have been necessary.

The features which contribute largely to the success of this great work are as follows:

Organization and devotion of staff and men.

Perfection of plant.

Design of plant suitable for each class of work.

Continuity of operations, making it possible for very complete plant, shops and trained men to be available.

Once each year the minister representing the government, and the engineers meet and go over the work with the representatives of the shipping and commercial corporations. Explanations of needs and the steps taken for improvements are exchanged and enthusiastic efforts and approval result.

All this work has been done to obtain a 30 ft. channel, and as the size of the vessels using the river is steadily increasing, so

road company. The section between Renne and Superior Junction, a distance of 200 miles, is just east of Winnipeg. Between these two points the line traverses a region of lakes and low granite hills, thus making the road a continual succession of deep rock cuts and heavy fills over the intervening shallow lakes, swamps and depressions.

This section was let to one contractor who divided it up into sections, and sub-contracted to other contractors and station men. The work was in an unsettled country and trails and wagon roads had to be built from the bases of supplies. The winter season was long. All supplies and materials were expensive, owing to the long hauls. At times laborers were scarce and inefficient, when they were paid from \$2.25 to \$2.50 per day. Later wages became 20 per cent lower, with a great increase in its efficiency.

For this 200 miles of work the contractor will receive about \$11,000,000. At the av-

The salaries and expenses of the government engineers in charge of this \$11,000,000 worth of grading, by the end of November when the work will be completed, will amount to \$370,000, or 3.4 per cent. The preliminary and location surveys for this portion of the line are said to have cost nearly \$200,000.

Analysis of the above gives the following sub-divisions of costs for grading this 200 miles of heavy rock work:

Engineering, preliminary, location and construction....	5.00 per cent
Contractors' profits	6.25 per cent
Contractors' expenses of administration	5.75 per cent
Construction of camps and roads	5.50 per cent
Depreciation of contractors' equipment	7.00 per cent
Labor, explosives and supplies	70.50 per cent
Total	100.00 per cent

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Petrolithic Pavement: Method of Construction, Organization of Working Force and Data on Work Done.*

BY J. C. BLACK.

A smooth, hard and durable road surface, which can be constructed without excessive cost, has been an object long sought, and one, in a measure, attained by a number of different processes. Macadam in its various forms was the first great step in this direction, while since its advent the variety of methods and materials—many of them patented—has become so great that a mere mention of them would fill pages. From the users' standpoint, many forms of construction have proved successful, but from the position of the man who foots the bills for construction and maintenance the view takes, on a different aspect. The heavy traffic of a city *must* have something which will carry it, and if the cost is great, so, generally, are the funds available to meet it. But in the city's residential districts, in the business and residence sections of small towns and villages, and in the country districts, the cost feature can be given no place of secondary importance.

Petrolithic pavement originated in southern California some eight years ago, and since that time has given such great satisfaction that it is now to be found in many parts of the United States, and is even securing a foothold in foreign countries. But before discussing the advantages which have led to this popularity, let us consider its construction.

In brief, petrolithic pavement consists of a compacted mass of earth, crushed rock or gravel and asphaltic oil, although, since the lighter oils in which the asphaltum is dissolved do not remain permanently in the pavement, but disappear (mainly by evaporation) within a few months after its completion, we may properly call it a mixture of earth, rock and asphalt. The rock is intended to act as a wearing coat, and hence is kept mainly near the surface. However, it is not the composition, but the manner in which it is treated, that constitutes the most important and characteristic feature of a petrolithic pavement, for this is the only method in which the entire material of the street is *tamped* into a compact mass of uniform density.

After the road has been brought approximately to grade and is properly crowned, the surface is broken to a depth of 6 to 9 ins., by plowing or otherwise, and then pul-

verized by farm cultivators and harrows or other machinery. The application of water, often in quantities amounting to several gallons to the square yard of surface covered, usually greatly expedites the pulverization. After the ground is reduced to a sufficiently fine condition, oil is applied at the rate of three-fourths of one gallon to each square yard of surface and is cultivated in. Another application of oil equal to the first is then made and cultivated, after which the ground is plowed 6 ins. deep, a gang plow generally being most satisfactory for this work. The plowing should be such as will thoroughly turn the furrow, and it will generally bring to the surface a small amount of soil which has been untouched by the oil. A slight amount of cultivating or harrowing serves to work out the ridges left by the plow, and the third application of oil, amounting to one gallon to the yard, is then made and cultivated in. After this it is advisable to put on the road grader, and it is the writer's experience that a liberal use of it is effort well spent. It will be observed that up to the present stage all the work on the road has been done along longitudinal lines—applying the oil and plowing must of necessity be so carried on, and while cultivating and harrowing may be done zig-zag fashion, it is generally more satisfactory to work in a straight line. While this work results in a fairly uniform mixture of soil and oil, there is a certain tendency toward the formation of streaks, and it is in the correction of this that the great benefit of the road grader as a mixing device becomes apparent. The soil is in a very loose and finely divided condition, so that with the grader blade set at an angle, a deep cut may be made, and by thus shifting the material from side to side a number of times, the streaks may be entirely removed.

The road is now brought back to grade, and the petrolithic rolling tamper is set to work. This tamper consists of a roller about 3 ft. in diameter, the surface of which is studded with iron teeth or feet 9 ins. long and terminating in a slightly rounded surface of about 1 sq. ins. area. The total weight of the machine is between 4,800 lbs. and 5,000 lbs., and as there are 10 or 11 ft. in a row, the weight on each is approximately 450 lbs., or over 100 lbs. to the square inch of surface. The device is patented, and is for sale by the Petrolithic Pavement Co. of Los Angeles. It is drawn by four horses, from four to six being required, according to conditions. As it passes over the loose material of the street, the feet sink to a depth of 6 or 8

ins., and being flat ended each one leaves a small, compact mass of earth and oil at the place it struck. In order to secure uniform results and prevent the too rapid tamping, a cultivator must be used in connection with the tamper. The cultivator should be adjusted at first to work to approximately the same depth as the tamper, but after two or three trips over the ground, should be raised a notch. After this it should be raised from time to time, but never more than a single notch at a setting, and care should always be taken to avoid too great haste and consequent imperfect tamping. It will be observed that this process builds the pavement "from the bottom up," so to speak, thereby producing a dense mass for the full thickness.

When the road has been tamped so that 2 or 3 ins. of loose material remain on the surface, the tamper should be taken off and the surface smoothed with a road grader or drag. After this, a 2 or 3 in. layer of 1½-in gravel or crushed rock should be spread upon the road and cultivated so as to mix it with the earth. The rock may be spread by hand, in which case dumping should begin at the end of the road where the wagons arrive, so that they may travel over it instead of over the loose earth, or it may be dumped in a single line down the center of the road, and then spread with the grader. In point of cost, one method offers little advantage over the others. The hand spreading usually gives more uniform results. After the rock is spread and cultivated, the last coat of oil, amounting to one gallon to the square yard, is applied, and the ground again cultivated. It should then be plowed as deeply as possible without disturbing the tamping already done. A few trips of the cultivator will smooth out the surface, and the tamper may again be set to work. When only a small amount of loose material (say an inch) remains, the cultivator may be taken off altogether, and the surface given a light treatment with a grader or drag before the tamper finishes its work. A smooth roller will improve the appearance of the newly completed road, but will add little to its efficiency or durability. The use of water from time to time during the work is a necessity, but because of varying conditions of weather and variety of soils, fixed rules for its use are impossible. In general it will be found that sandy soils must be kept wet from start to finish of work, while clay or adobe requires comparatively little water, and that mainly during the tamping process. If too much water is used on soil of this nature, the almost inevitable result will be clogging of machinery and consequent delays. For applying water, the oil wagons will be found entirely satisfactory.

It is needless to remark that the details of building a petrolithic pavement may be varied considerably, and that good results can be obtained in several ways. In fact, as in many other lines, there are no two pieces of work which can be conducted in

*From the California Journal of Technology, October, 1908.

exactly the same manner. The description just given is a modification of Specifications No. 61 of the city of Los Angeles, and has furnished excellent results. Some of those who have been most successful with this form of construction prefer to put the rock on the road before any tamping has been done. This is cultivated, and after the final coat of oil has been applied is plowed under. It might be thought that this would result in the rock being distributed through so great a thickness of soil that its value as a wearing surface would be lost, but the fact is that even when plowed under as much as 6 ins. the cultivation rapidly brings it to the top. If it is attempted to mix it with too small a quantity of soil, a large amount of rock will remain loose on the surface, and must be removed entirely from the street.

Most of the older petrolithic roads of southern California were built without the use of any rock or gravel, and the satisfaction they have given proves that where the price of rock is high and the keeping down of expenses imperative an excellent pavement may be built of nothing but the natural material of the street mixed with oil.

As to the character of soil in which petrolithic pavement may successfully be built, almost anything will do, provided it is free from a large amount of alkali or other ingredient which will cause decomposition of the oil. In sand the adhesive qualities of the oil will hold the particles together and make possible a good road, where otherwise some expensive paving material would be necessary. No soil gives better results than adobe, although it is hard to work, and consequently may slightly increase the cost. Between the extremes of sand and adobe equal satisfaction will be found.

The greater the amount of asphalt in the oil, the better, and the specifications of the city of Los Angeles require a minimum of 70 per cent. Natural oils having this amount of asphalt are difficult to obtain, but the Sunset District produces some which run from 75 to 80 per cent or even more. These are used exclusively for road oils, and can generally be had at a reasonable price, say 50 cts. per barrel of 42 gallons. Refinery products or residuums are frequently used, and these prove satisfactory when the quality of the asphalt contained in them is unimpaired. The objection to their use arises from the fact that an overheated or burned asphalt lacks the adhesive qualities necessary in a good road oil. A special and expensive test is necessary to determine whether overheating has taken place, and as it should be applied to every carload, besides causing delay, it will form quite an item of expense. Care should be taken to get an oil comparatively free from water and sediment, many specifications requiring the rejection of all oil containing more than 2 per cent of such foreign matter.

It is commonly required that the oil be applied to the road at a temperature of not less than 150 degrees F., and some oils, be-

cause of their viscosity, cannot be easily handled at a lower temperature. Although there are still some advocates of the use of cold oil, the general opinion is "the hotter the better." For heating the oil a portable boiler of some sort is generally used. The oil may be heated in the cars in which it is delivered, which are usually equipped with steam pipes for this purpose, or it may be run into a tank or pit in which a steam coil has been set. In soil of a clayey nature, a pit without lining may be used, as the oil will penetrate the ground only a few inches. An oil pump with the necessary valves and connections for unloading from car and loading into wagons, will complete the heating establishment.

Oil tank wagons are built of various capacities, the common sizes holding from 800 to 1,000 gallons. The distributors, of which there are several good designs, are attached to the rear of the tank, and spread the oil for a width of 6 or 7 ft. Some are divided into three or four sections, so that a narrower strip may be covered if desired. The oil holds its heat very well, and if conditions demand, the heating plant may be situated several miles from the work and still allow of the delivery of oil at the required temperature.

Warm weather is desirable for carrying on the work, as when it is cold the oil tends to drag or form into chunks, with resulting irregularities and soft spots in the finished roadway. The road may be opened for traffic as soon as the tamping is finished.

A complete outfit for building petrolithic pavement will be about as follows, though, of course, the magnitude of the work will determine the number of pieces of machinery necessary. It is often possible to rent a portion of the plant, and some cities have their own outfits, which they are prepared to rent to contractors, generally at so much a block:

- 1 foreman.
- 1 grader man and oil wagon operator.
- 1 fireman.
- 7 teamsters.
- 3 laborers.
- 35 horses or mules.
- 1 portable steam boiler, with fittings.
- 1 oil pump and connections.
- 1 pit or tank of not less than 10,000 gallons' capacity, and fitted with steam heating coils.
- 1 oil wagon and distributor.
- 1 road grader.
- 1 road drag (home made).
- 3 dump wagons, for rock.
- 1 rooter plow.
- 1 gang plow.
- 3 cultivators.
- 2 tampers.

The accompanying figures give an average of the amount of labor and material per 1,000 sq. ft. on several streets, all of which were in clay or adobe soil. In sandy soil more tamping and more water are required, but the preliminary work is much

easier. The amount of work necessary varies widely, and depends entirely on local conditions, but by inserting rates of wages and costs of materials in this table an approximation to the cost of doing the work may be obtained. Proper allowance must, of course, be made for interest and depreciation or for rental of plant.

	Hours.
Superintendence	2.10

Pulverizing.

Rooter plow with 6-horse team and driver	.43
Cultivator, with 4-horse team and driver ..	.42
Tamper with 6-horse team and driver ..	.23
Hand labor.....	.23

Oiling.

Oil—3½ gallons per square yard.....	400 gallons
Fuel oil.....	10 gallons
	Hours.
Fireman, heating oil.....	2.00
Oil wagon with 6-horse team and driver ..	.77
Oil wagon operator.....	.47
Hand labor.....	.17

Mixing.

Rooter plow with 6-horse team and driver	.17
Gang plow with 4-horse team and driver ..	.30
Cultivator with 4-horse team and driver ..	2.40
Hand labor.....	.80

Watering.

Water—5½ gallons per sq. yd.....	.610 gallons
	Hours.
Water wagon with 6-horse team and driver	.58

Crushed Rock.

Crushed rock, spread 3 ins. deep.....	9.3 cu. yds.
	Hours.
Wagons (hauling) with 2-horse team and driver.....	6.17
Labor, loading into wagons.....	4.67
Labor, spreading rock on roadway.....	.97

Grading.

Road grader with 6-horse team and driver	.55
Grader man.....	.55
Road drag with 4-horse team and driver ..	.10

Tamping.

Tamper with 6-horse team and driver.....	2.50
Cultivator with 4-horse team and driver ..	1.20

Smooth Rolling.

Roller with 6-horse team and driver.....	.30
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Miscellaneous Work.

Labor—Removing large stones, trimming up, etc.....	1.00
Wagons with 2-horse teams and drivers	.17

At the present time contract prices in southern California, where competition is keen, range from 3 to 4 cts. per square foot, but in the vicinity of Berkeley, because of the greater cost of oil and the shorter season during which work may be carried on, they would be higher. Where oil of proper composition is unobtainable, other products may be used. At Laurelton, on Long Is-

land, tarvia has been successfully employed, as described in *ENGINEERING-CONTRACTING*, Sept. 16, 1908.

As to the success of petrolithic pavement, the fact that several of the towns of southern California, in which it has been used the longest, are now adopting it almost exclusively, while its use on the residence streets of Los Angeles, Pasadena and other cities is steadily increasing, speaks sufficiently. In the vicinity of Berkeley it may be found at the Broadmore Tract, San Leandro, at Vallejo and Antioch.

Aside from low first cost and ease of maintenance and repairs, the qualities which have led to the popularity of petrolithic pavement are its smoothness of surface and nearly dustless condition, its silence under traffic and its resistance to the wear of automobile tires.

Experimental Earth Roads in Illinois.*

The most important problem to solve in road building in Illinois, is the possible utilization of the heavy soils in such a manner as will produce a road which will be able to sustain traffic satisfactorily the year around. Until more failures are encountered and fewer methods left untried, it is believed that this problem is not insurmountable.

As a beginning on this work, there was constructed a stretch of earth road in a manner somewhat different than is usually employed. It was the intention when this work was undertaken to experiment with a mixture of tars and oils with the earth to the end that some waterproof coating might be formed in a comparatively inexpensive manner that would be durable under ordinary conditions of traffic.

This part of the work it was impossible to carry out from the fact that the season was so rainy during the summer of 1907 that at no time were the roads sufficiently dry to attempt the application of either tar or oil. This work will, however, be carried on during 1908, if the weather conditions are favorable.

The following is an account of the earth road experiments as far as undertaken. It is believed that this work is well worth doing, and that it is the best method of preparing the earth roads for maintenance with a road drag. Similar experiments on other soils will be undertaken during the coming season.

During 1907 a stretch of road near Springfield, Sangamon county was selected and construction undertaken in the following manner: The road roller was provided with very blunt-ended spikes or spuds set in the rear wheels of the roller in the place in which the usual spikes are fastened. These spikes or spuds were circular and 4 ins. wide at the end and 6 ins. broad at the base. They are tapered in

this manner so that as the roller moves over the road they will not tear up the edges of the holes they make. On a 10-ton roller it is estimated that the pressure of these spuds upon the road surface is about 500 lbs. per square inch. As the road becomes hard, the entire weight of a single driver was borne up by one of the spuds, thus producing this large pressure. On some sections the road was first plowed. The material was drawn to one side of the road which was then graded and rolled with the spuds in the wheel until the road-bed was firmly compacted. The earth was thrown back on the road in layers, and rolling continued until the compacted layer was about 18 or 20 ins. in thickness, extending for about 16 ft. Owing to the very wet weather, the work on the Springfield section was not completed before it was necessary to start a similar piece of work at Bement, Piatt county, where the road commissioners were very anxious that the work should be done, and arrangements had been made to do the work at a certain time. At Bement about 1¾ miles of road were constructed. The method of construction on the different sections was somewhat varied. One was made by cutting out the center portion of the road until a broad trench 8 or 10 ins. deep was formed for a width of 12 to 15 ft. The bottom of this trench was then rolled as already described. The surface, after the roller had gone over the road, had very much the appearance of a huge waffle as the spuds had filled it full of holes. The rolling was continued in this manner until the spuds penetrated scarcely one-half inch. The earth that was dug from the trench was replaced and the rolling continued until the center of the road was firm and compact.

Another section of the road was made in practically the same manner with the exception of cutting out the trench as this was not believed to be essential. The surface was well rolled and the material worked in from the sides and spread with the road grader, rolling continuing in the meantime. Special care was taken of the drainage and the ditches were shaped with very sloping sides to prevent their caving in.

On another section the spuds were removed from the wheels and the earth was rolled with the smooth wheels. This is not believed to give as good results as where the earth is tamped in with the spuds as just described.

The idea of this method of construction was based on the theory that a thick layer of well compacted clay or impervious earth will, if given the proper oval shape, shed water, and not become as muddy or cut through as readily as is ordinarily the case.

The road was inspected, March 9, 1908, and the surface found to be very much cut up. The road did not, however, contain as much water, nor was it cut nearly as

deep as the roads which had not been graded and rolled.

An examination of the road-bed showed there was perhaps an average of 4 or 5 ins. of mud, below which the road-bed was solid and contained but little moisture. The character of the soil, however, which is an extremely sticky "gumbo," rendered the road practically as difficult to travel during the wettest period as other roads. Indeed, it was found at times that owing to the fact that the road surface of the experimental road was somewhat drier, it was actually more inconvenient for traffic than roads which were much wetter. This is explained by the fact that this soil is such that when it contains a certain amount of moisture, it adheres to the wheels and practically prohibits travel; if it is either wetter or drier than this particular condition, the mud does not adhere to the wheels.

The surface of this road remained intact and offered no impediment to traffic until the first frost appeared. It was then observed that the road peeled up in cakes, clinging to the wheels and made extremely bad going. A number of attempts have been made during the winter to drag the road, but at no time has there been sufficient moisture on the road to drag it properly. There is little doubt but that this road will dry out and become good considerably earlier than adjoining roads.

The question to be decided is, whether or not the road by this treatment was enough better on the whole to pay for this work that was done at a cost of \$250 to \$300 a mile. It is the opinion of a number of the residents and those who have used the road that this is the case.

Where repeated, it will probably be a very great advantage not to work the road for as great a width and leave, if possible, the grass or sod undisturbed at least at one side of the road, which will afford, where the soil is stickiest, a place where vehicles can travel more conveniently than upon the sticky road surface, proper. There is little question that roads of this character would be vastly improved if it were possible to cover them with sand which would become incorporated with the soil. This method, it is understood, has been tried to some extent in portions of Mason county and proved successful.

There is, however, difficulty in many places where there is gumbo soil to obtain sand at a cost that would justify this treatment.

It will be the endeavor to make similar experiments in earth road construction on other varieties of soil. Experience has shown that on many well traveled roads dragging is only partially successful where the traffic is so great as to cut up the road before it has time to harden, but if this road could be put in good, hard, smooth shape to begin with, it could be maintained in very much better condition with the drag than otherwise.

*From the annual report of the Illinois Highway Commission, Mr. A. N. Johnson, State Engineer.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Equipment for the Electric Operation of the St. Clair Tunnel of the Grand Trunk Railway.*

The St. Clair Tunnel was opened for traffic in 1890 by the St. Clair Tunnel Co., organized as a subsidiary company to the Grand Trunk Ry. The tunnel, located under the St. Clair river, is the connecting link between the terminal of the Western Division at Port Huron, Mich., and the terminal of the Eastern Division at Sarnia, Ont. The length of the tunnel from portal

ward toward the east, just enough to provide for the proper drainage of any seepage water.

A single track extends through the tunnel, while a double track is laid in both of the tunnel approaches. The necessary tracks for handling the freight and passenger traffic are provided in the yards at Port Huron and Sarnia. The map and profile of the zone operated by the St. Clair Tunnel Co. is shown by Fig. 1. The tracks in the yards and on the tunnel ap-

proaches are shown to a large scale in the same drawing. The tunnel shell consists of cast iron rings built up in sections, the inside diameter being about 19 ft. The hydraulic shield was used in advancing the bore from each of the tunnel portals. A vertical shaft was sunk near the bank of the river on both the American and Canadian sides. The disposal of the rainfall on the tunnel approaches required particular attention. The areas of the Port Huron and Sarnia approaches are approximately 11 and 13 acres respectively. Water precipitated on these areas during a rainfall is discharged

into waste ditches on the bank above by means of pumps of large capacity. Retaining levees have been constructed, so arranged as to impound a large proportion of the water falling on the approaches. By this method the pumps have to handle only the water falling on the central portion of the approach during the rainstorm. Later the impounded water is discharged into the pump sump by valves provided for the purpose.

As is evident, this pumping service is of great importance in the operation of the tunnel, as, should the tunnel become flooded with water, entire interruption of the traffic would ensue. For the operation of the steam drainage pumps, boiler plants were provided at each portal, and attendants were constantly on duty, it being nec-

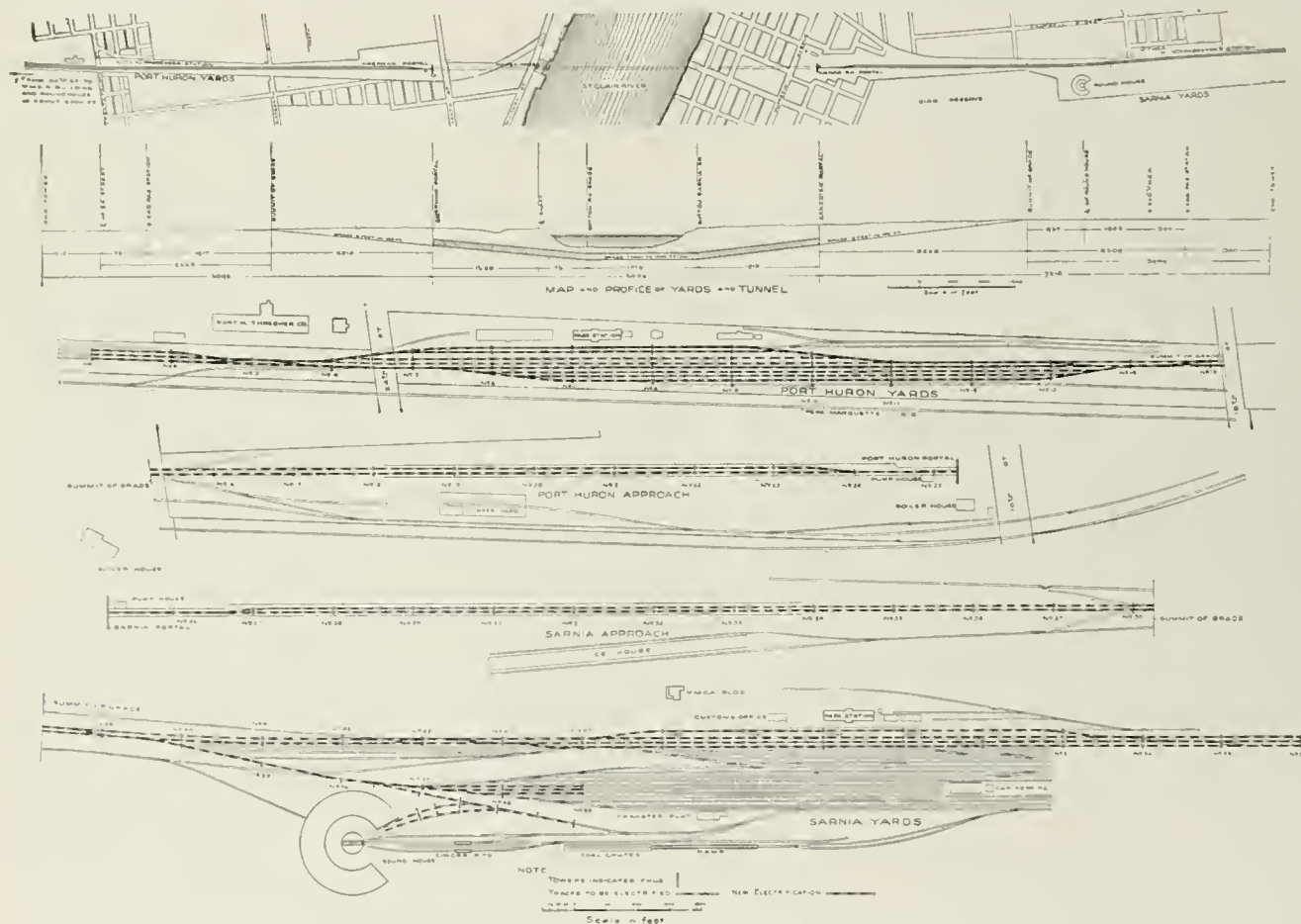


Fig. 1—Map and Profile of Zone Operated by St. Clair Tunnel Co.

to portal is 6,032 ft. The open tunnel approaches are of considerable magnitude, that on the Port Huron side being slightly over 2,500 ft. in length, while that on the Sarnia side is nearly 3,300 ft. in length, the total distance between the American and the Canadian summits being 12,000 ft., or about $2\frac{1}{4}$ miles. The grade on the tunnel approaches and the inclined sections of the tunnel is 2 per cent, while the flat middle section of the tunnel, about 1,700 ft. in length, has a grade of 0.1 per cent down-

ward toward the east, just enough to provide for the proper drainage of any seepage water.

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*Condensed from a description prepared by F. A. Sager, Assistant Engineer, with Blon J. Arnold.

of themselves and have handled the traffic in a satisfactory way throughout their service. Their maximum tractive effort limited the weight of the trains handled to about 760 tons, and even with this load the speed up the 2 per cent grade was often very slow. With the constantly increasing traffic, at times the capacity of the tunnel with its steam equipment was taxed in handling the tonnage delivered to the Tunnel company by the adjacent divisions of the Grand Trunk Ry., and it was thought desirable to make such changes in the operation of the tunnel as would increase its possible capacity for handling traffic, and at the same time obviate the danger and inconvenience due to the presence of the locomotive gases in the tunnel.

Proposed Systems for Increasing Capacity.—The advantage of the use of electric locomotives, on account of the freedom

current system both with and without battery, as well as estimates on the alternating current systems. Complete specifications were prepared, covering both the direct and alternating current systems, and propositions on these received and considered. Decision was finally made in favor of alternating current, using a 3-phase system for the distribution of power required for pumping and for shop motors with single phase distribution for locomotives and lighting.

Service Conditions and Requirements.—The St. Clair Tunnel Co. is operated as an independent division of the railroad, the trains being delivered by the Western Division in the yards at Port Huron, and taken by the tunnel locomotives through the tunnel, and delivered to the Eastern Division at the yards in Sarnia, the west-bound trains being handled in the reverse

three times larger than the actual maximum demands up to the present time.

It was estimated that the pumping service, for which adequate provision must be made, would require the installation at the Sarnia portal of two pumps each of capacity of 5,500 gallons per minute, and at the Port Huron portal the installation of two pumps each with a capacity of 4,000 gallons per minute. To provide absolute continuity of service, duplicate pumping equipments were provided in each portal, as well as duplicate feeder lines leading from the power plant to the pump houses. As noted above, the pumps must always be in readiness for operation day and night throughout the entire year, which in case of electrical pumps simply necessitates the presence in the pump house of a pump operator and the continuous operation of the power plant.

The lighting service to be provided for is of minor importance in so far as the amount of power required at both Sarnia and Port Huron is concerned, this being somewhat less than 100 kw. The power requirement for motors in the round houses at Port Huron and Sarnia is about 100 kw. for both shops.

To furnish electrical energy for the service outlined above, the provision must be made in the power plant for supplying single phase current for the electrical locomotives, 3-phase current for the pumping service, and 3-phase and single phase current both for the power and lighting service at various points throughout Port Huron and Sarnia, as well as for a small amount of arc lighting.

Locomotives.—Three locomotives Fig. 2 have been provided for this service, each consisting of two half-units, each half-unit mounted on three pairs of axles driven through gears by three single phase motors with a nominal rating of 250 H. P. each, the nominal horse power of the complete locomotive unit being 1,500. In so far as the electric motors have a very liberal overload rating, it is easily possible to develop 2,000 H. P., and on occasion in excess of this, in one locomotive. The half-units are duplicate in every respect, and as the multiple unit system of control is used, they can be operated when coupled together with the same facility that a single phase half-unit can be operated.

As previously stated, the locomotives are designed to develop a drawbar pull of 50,000 lbs. at the comparatively low speed of ten miles per hour. The locomotives are powerful enough to start a 1,000-ton train on a 2 per cent grade in case this should be necessary. At a test made on a half-unit, using a dynamometer car, it was found that a single half-unit developed 43,000 lbs. drawbar pull before slipping the wheels. This was done on a comparatively dry rail, with a liberal use of sand. On this basis it would be possible to develop about 86,000 lbs. drawbar pull with a complete locomotive. The maximum speed of

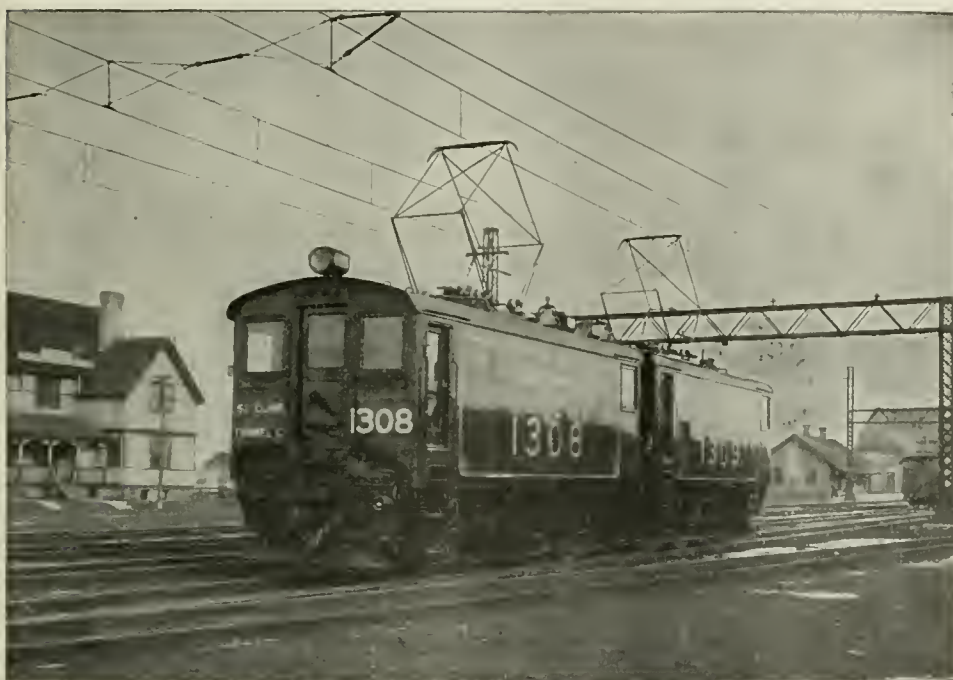


Fig. 2—Electric Locomotive in Sarnia Yards.

from smoke and the attendant discomfort, together with the possible greater economy in operation, led finally to the decision to provide an electrical equipment to handle the tunnel service, this equipment to provide for the operation of the trains through the tunnel by means of electric locomotives; the handling of the drainage and seepage water by means of electric pumps; the lighting of the passenger stations, the tunnel and the round houses by electricity, as well as furnishing a certain amount of power to the roundhouses; also, provision was made for a limited amount of outside lighting in the form of arc lamps. The different electrical systems available for such service were considered, and estimates as to the relative cost and efficiency of the various systems were prepared and submitted to the Tunnel company. These estimates covered the direct

order. The steam locomotives operating on the divisions adjacent to the tunnel are never operated through the tunnel.

In order to increase the capacity of the tunnel, it was desirable to provide for the maximum practicable tractive effort in the new locomotives. The capacity limit was determined by the maximum pull to which it was deemed wise to subject the drawbars on the mixed rolling stock that must be handled, without danger of breaking trains in two. For this reason the locomotives were specified of sufficient capacity to develop a drawbar pull of 50,000 lbs., when operating at a speed of 10 miles per hour. It was estimated that such a locomotive would be able to make the complete trip through the tunnel from terminal to terminal with a 1,000-ton train in 15 minutes, or four 1,000-ton trains per hour, which would provide a capacity for traffic about

the locomotives is 35 miles per hour. However, it is not the intention of the Tunnel Company to operate the locomotives at a speed in excess of 30 miles per hour. Speed indicators are provided, which indicate on a large dial, located in the locomotive cab near the engine driver's seat the speed at which the locomotive is running, and at the same time record the speed throughout the length of the run. This assists the locomotive driver in keeping the speed of trains within prescribed limits at all times, and furnishes records of the exact speed of the trains throughout all trips, for the inspection of the superintendent of the tunnel.

The locomotive cab is rectangular in section, constructed of sheet metal supported by structural steel shapes. Inside of the cab are located practically all of the apparatus used in connection with the locomotive, with the exception of the motors and the brake rigging. Included in this apparatus is a single phase transformer used for reducing the voltage from 3,300 to a voltage suitable for application to the motor. The transformer, as well as the motors, are air-cooled, the supply of air being furnished by an electrically driven blower, also located in the locomotive cab. The blower is driven by a single phase motor, the current being supplied at 100 volts by a tap from the main transformer. With the moderate supply of cooling air furnished by the blower fan, both transformers and motors are able to operate at full capacity with comparatively little increase in temperature above that of the surrounding air. The air for the cooling is taken through a suitably designed shutter located in the side of the locomotive cab, and is distributed through sheet metal ducts installed under the cab floor to the three motors under the cab, and to the transformer. From the latter the air passes either through an opening in the floor of the cab into the open air, or, if desired, into the interior of the cab. In the latter case an appreciable amount of heat can be secured from the main transformer for utilization in heating the cab during cold weather.

Motor driven air compressors are also located in the cab. The air brake equipment is of the standard type used for electric cars and locomotives, with the exception of the motors, which are single phase. They are operated by means of an electric controller, which serves to keep the normal air pressure at about 100 lbs. The compressed air is used for the purpose of operating both the automatic and straight air equipment on locomotive and train, and in addition for a variety of minor purposes in and about the locomotive. All of the contactor switches used in controlling the operation of the locomotives are air operated, the air valves being operated by direct current electrical control. This is also true of ringing the bell, blowing the whistle, raising and lowering the trolley, and the application of sand to the tracks.

Speed control of the locomotive is ef-

fectuated by varying the voltage at the terminals of the motors. This is obtained by making connection with various transformer taps by means of the air operated, electrically controlled contactor switches. Electric control of the contactors is effected through the master controller, which in the electric locomotive replaces the throttle valve in the steam locomotive. The current for the master controller is furnished by a small storage battery operating at about 20 volts, the battery in turn being charged by means of a small motor-generator set provided for the purpose. The electric controller has 21 points in all, 17 of which are running points. This provides for an increase in the speed of the locomotive from the lowest running speed to the maximum speed by very slight gradations, thus making it possible to maintain a practically constant drawbar pull, while the locomotive is accelerating the train. This is very desirable, in so far as the minimum variation in the drawbar pull while handling the train through the tunnel decreases the liability of breaking the train in two. Particular attention was given this phase of the train operation in designing the locomotive, and the resulting remarkable decrease in the number of breaks-in-two since the operation with electric locomotives have been inaugurated is a source of great satisfaction.

On the master controller is also located the reverse lever, which controls through the electrically operated solenoids the air operated contactors used in reversing the motor connections. Here also are located the push buttons, which serve to raise and lower the trolley, operate the front and rear sanders, reset the circuit breaker, and ring the bell. The ringing of the bell and the application of sand by means of the front and rear sanders are also controlled by foot pedals, thus making it possible for the operator to perform these functions while his two hands are employed in operating the master controller and the air.

The balance of the equipment of each locomotive, consisting of the sand boxes, the seats for the drivers, ammeters, voltmeters, wattmeters, the banks of contactors, the preventive resistance coils, circuit breakers, auxiliary storage battery and motor generator set for charging it, are all installed in a compact manner inside of the cab, and are supported on structural steel work.

Each half-unit is arranged for operation in either direction; air valves, a master controller and ammeter being located at each end of the cab. By means of cable couplings, the control system of two or more half-units can be thrown in parallel, thus providing for the operation of any number of half-units from any master controller. In this way the two half-units are generally operated in the handling of freight trains through the tunnel. The passenger traffic can ordinarily be taken care of by a single half-unit.

The current is collected from the trolley

wires suspended at a distance of 22 ft. from the track by means of a sliding bow pantograph trolley. In so far as the trolley wire extends throughout the length of the tunnel, no additional provision has to be made for the collection of current while the locomotive is passing through the tunnel. Electric headlights are provided, as well as lights for the illumination of the interior of the cab and the dials of the indicating instruments. The heating of the cabs is provided for by means of standard electric heaters. Heat is also available for drying the sand stored in sand boxes. In general, the M. C. B. standards have been conformed with in so far as couplers, wheel treads, etc., are concerned. The general dimensions of the half-units are as follows:

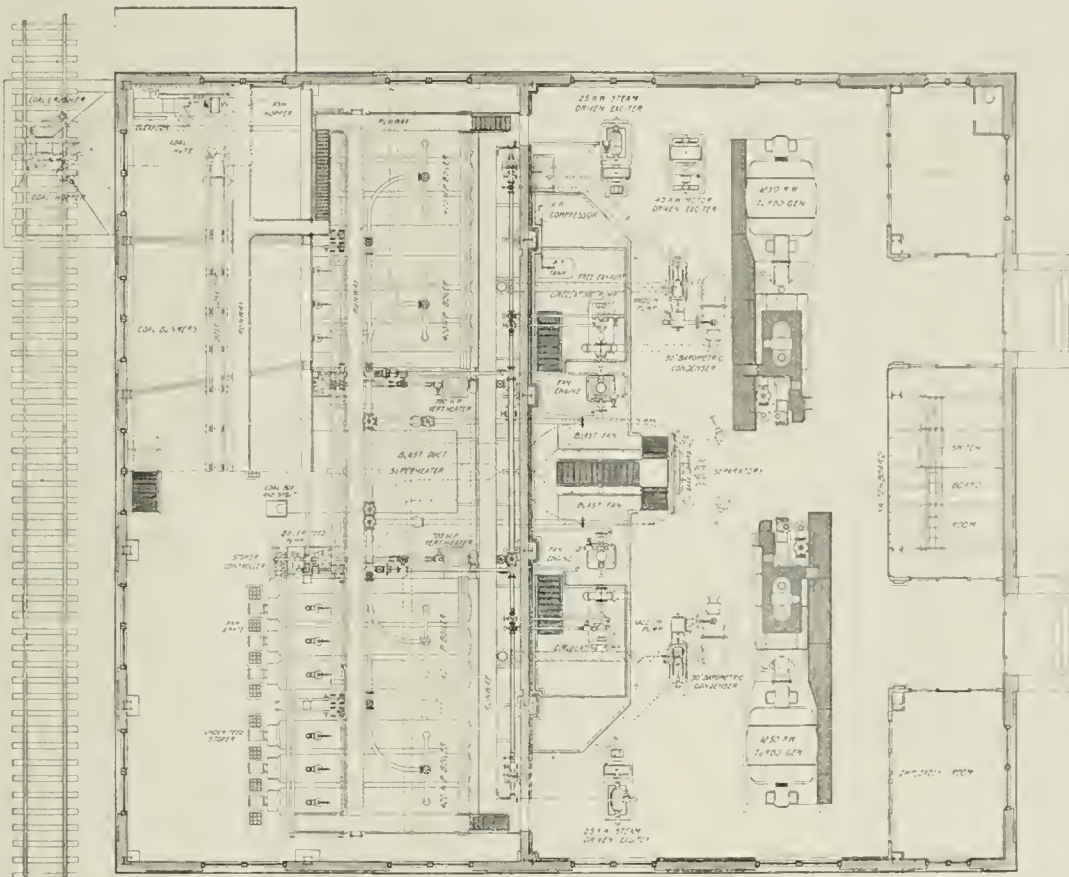
Length over all	23 ft. 6 in.
Height from top of rail to top of roof	13 ft.
Height from top of rail to top of pantograph bow when lowered.....	14 ft. 11 in.
Width of cab over all.....	9 ft. 8 in.
Total weight of locomotive half-unit, fully equipped	.67½ tons
(This weight is practically evenly divided over three drivers.)	
Weight of complete locomotive unit	135 tons
Length of rigid wheel base.....	16 ft.
Diameter of driving wheels.....	62 in.
Normal speed of train, ascending 2 per cent grade (miles per hour).....	10
Normal speed on level tracks (miles per hour)	25 to 30

In service it has been found that the locomotives will very readily handle a 1,000-ton train at from 11 to 12, and possibly 13 to 14 miles per hour on a 2 per cent grade, thus demonstrating their ability to more than fulfill the specified performance.

Pumping.—The second service to be provided for electrically consists of the pumping necessary to free the tunnel approaches from water due to rain storms of melting snow, and the removal of a small amount of condensation and seepage water collecting in the tunnel. For this purpose pumping plants have been installed at both tunnel portals, that at the Port Huron entrance consisting of two centrifugal pumps, each capable of delivering 4,000 gallons per minute, driven by direct connected, 100 H. P., 3-phase, 25-cycle, 3,300-volt, induction motors, and that at the Sarnia entrance consisting of two 5,500-gallon pumps driven by two 200 H. P. motors of the same type. In addition a 150-gallon pump driven by a small induction motor is located in each pump house, these pumps serving to take care of the small amount of water that is constantly finding its way into the drainage wells. The motors in the pump houses are controlled by oil switches located on suitable panels. Provision is made on the panels for connecting the motor bus bars with either of two feeders leading from the power plant.

The centrifugal pumps used in this ser-

nel opening more than 9 ins. This has been accomplished by bolting the tunnel shell special iron brackets, each of which supports two spool-shaped insulators. These insulators in turn support steel messenger cables, which are drawn taut throughout the length of the tunnel and attached at the tunnel portal to special brackets. Special clamps are attached to these messenger cables at points between the insulator supports, and these in turn serve to support the two trolley wires. The insulating supports are attached to the tunnel shell at intervals of 12 ft., as also are the clamps connecting the messenger cable with the trolley. This method provides an attachment at once sufficiently rigid to maintain the proper clearance between the



The columns at one end of the transmission bridges have been lengthened, for the purpose of supporting the transmission wires which supply current for the power and lighting service at the roundhouses and stations, as well as for the arc light circuits. Overhead lines terminate in the pump houses, at either tunnel portal, where they are connected with the underground feeder system at the panel boards.

All feeder lines connecting the various parts of the equipment to be supplied from the power plant are carried in the tunnel conduits. For this purpose four conduit lines have been laid on either side of the tunnel throughout its length. Connection has been made with these conduit lines at a point about 1,700 ft. from the Port Huron portal, with a vertical shaft extending from the top of the tunnel to the surface of the ground, terminating at a point about 75 ft. from the power plant. The overhead feeders, terminating as above noted in the portal pump houses, are continued as underground feeders down through the tunnel and up the shaft, finally terminating in the switchboard at the power plant. For the pumping service, two independent feeders are laid from each portal pump house, one being installed on either side of the tunnel and both terminating at the power plant switchboard. The heavy feeders for

sible for coal to be received and handled by boat in case this should be found desirable. The power plant building covers a ground area approximately 100 ft. square. The building is divided longitudinally by a fire wall separating the boiler from the turbine rooms. In the front elevation, the height of the brick work above the water table is about 36 ft., the water table being about 2½ ft. above the grade on the front side of the building. As the building is located on the side of a hill flanking the river, the ground line falls away rapidly alongside of the building until the grade line of the dock is reached, which is maintained for all entrances at the rear, this being 21 ft. below the street level. The foundation up to the water table is constructed of mass concrete; the building superstructure is of steel and massive paving brick of dark brown color. The building trimmings are of cut stone and con-

under designs and specifications by Mr. Bion J. Arnold, of Chicago, Ill., as engineer, and by the Westinghouse Electric and Manufacturing Co., as contractors.

The production of gold in the United States for 1907, according to figures recently given out by the U. S. Geological Survey, was 1,374,827 ounces, valued at \$90,435,700. In 1906, a total of 4,563,333 ounces was produced, valued at \$94,373,800.

According to statistics recently issued by the U. S. Geological Survey the production of iron ores in the United States in 1907 amounted to 51,720,619 long tons, as compared with 47,749,728 long tons in 1906, with 42,526,133 long tons in 1905, with 27,644,330 long tons in 1904, and with 35,019,308 long tons in 1903. The value at the mines of the ore mined in 1907 was \$131,-

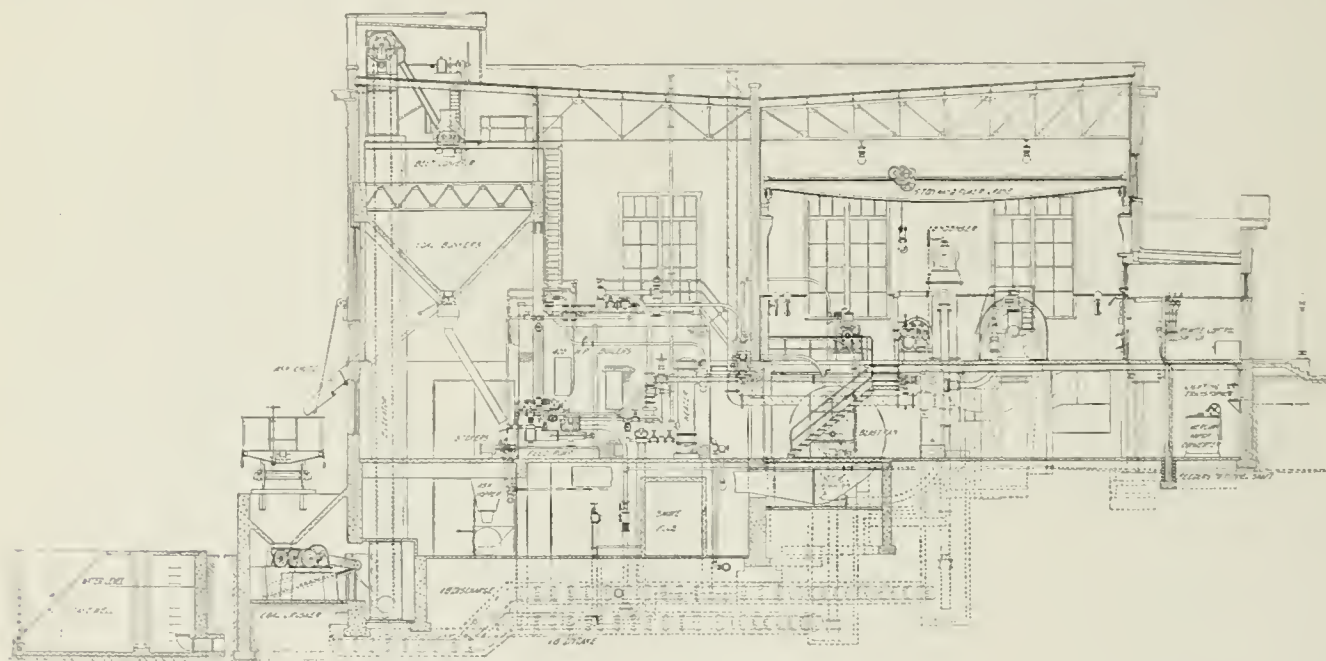


Fig. 4—Sectional Elevation of Power House.

supplying the locomotive current to the trolley extend from the tunnel through the vertical shaft to the power house. This arrangement provides for all feeders leaving the power plant underground. The cables are paper insulated, lead encased and are installed in tile ducts.

Power Plant.—The power plant is located on the Port Huron bank of the St. Clair river, about 100 ft. distant from the center line of the tunnel. The building is 50 feet from the street property line, which provides ample space for a lawn in front, while the back building line is about 50 ft. distant from the retaining wall, which serves as a dock line along the river. Sufficient space is afforded between the building and the river front for sidetrack, a spur of the Grand Trunk Ry., which is used for bringing in coal and various supplies needed for the operation of the power plant, as well as the removal of ashes. The proximity of the river makes it pos-

sible for coal to be received and handled by boat in case this should be found desirable. The general design of the building is along simple massive lines and will present a very attractive appearance.

The machinery equipment and its arrangement are clearly shown by the plan and section of the power house Figs. 3 and 4. As will be seen, the plant throughout is provided with all the labor saving and economy securing devices in modern power plant practice. The main features of the plant may be summarized as follows:

Number of turbo-generators.....	2
Normal capacity of each generator (k.w.)	1,250
Generator voltage (volts)	3,300
Generator frequency (cycles per sec.) ..	25
Generator speed (r. p. m.)	1,500
Number of boilers	4
Normal capacity of each boiler (H. P.)	400
Capacity of coal bunkers (tons)	750
Capacity of hand-power crane (tons) ..	15

The work as described was carried out

996,147, as compared with \$100,597,106 in 1906, and with \$75,165,604 in 1905. As in the eight preceding years, the production of iron ores in the United States in 1907 was never equaled by that of any other country.

According to a report submitted to the City Council of Chicago, Ill., the cost to the city for electric lighting from 1903 to 1907 has been as follows:

Year.	Production			Total cost
	No. of arc lamps.	arc cost per lamp.	ion cost per lamp.	
1903	4,827	\$45.12		\$85.11
1904	5,034	46.10		85.15
1905	5,713	43.57		78.96
1906	6,692	42.56		76.46
1907	7,647	44.74		81.61
Average for five years...		\$44.42		\$81.46

The plant is owned and operated by the city.

Methods and Costs; Some Old, Some New.

Cost of Building a Barbed Wire Fence.—Mr. Terrell Bartlett, C. E., has furnished us the following data on building a short length of barbed wire fence near San Antonio, Tex. Five-inch cedar posts set 30 ins. deep and 15 ft. on centers were used, with four strands of wire. The labor on the holes was paid by the hole according as each was in earth, part in, or all in adobe. Other labor, \$1.50 per day:

	Cost Per Foot of Fence.	Cost Per Mile.
Material:		
Posts, at 16 cts.....	\$0.0107	\$56.30
Wire and staples.....	0.0091	48.20
Total material.....	\$0.0198	\$104.50
Labor:		
Digging holes, average.....	\$0.0076	\$40.40
Setting tamping and stringing wire.....	0.0067	35.50
Total labor	\$0.0143	\$75.90
Total cost	\$0.0341	\$180.40

Removing Water with a Tramway System.—An aerial tramway system used in transporting clay was put to a rather interesting use recently. The tramway system has a carrying capacity of 300 tons of clay per day, 12 buckets being used, each holding 1,000 lbs. Power is supplied by a 15-H. P. gas engine at the loading station, which is on low ground. In order to load the buckets directly from the surface cars, running from the clay banks, a trench, 12 ft. deep, 80 ft. long and 20 ft. wide, was dug. One end of the trench is directly under the loading station and the buckets of the tramway system run all the way through it. A pump was used to keep the trench free from drainage water, and successfully met the requirements of all ordinary conditions. During a season of heavy rains, however, the pump broke down, and the trench became entirely filled with drainage water. As the pump was badly damaged, necessitating sending away for new parts, it was decided to start the tramway and attempt to remove the water in this way. The experiment was a success and the 12 buckets of the tramway system hauled out the entire 12 ft. of water from the trench in less than a day.

Testing Bearing Power of Soil.—The following method was used in testing the bearing power of a gravel bearing strata preliminary to the construction of three new bridges over the San Lorenzo River at Santa Cruz, Cal. A triangular frame, consisting of 6x2-in. timbers about 7 ft. on a side, was supported on three legs, each a 4x6-in. post. Mounted on the frame was a horizontal platform,

8 ft. square, upon which rested a large galvanized-iron water tank. The legs of the apparatus were seated accurately, with an even bearing and uniform contact with the surface of the gravel at the point where the test was to be made. The tank was adjusted on the platform so as to be symmetrically situated with respect to the three legs, and the bottom carefully leveled, and its height above the ground noted in order to measure subsequent settling. Water was introduced into the tank. When a load of about $3\frac{1}{2}$ tons was applied, a settlement of $\frac{1}{2}$ in. was noted. The combined area of the footing was 72 sq. ins., or $\frac{1}{2}$ sq. ft., which, if a proportionate ratio be allowed, brings the actual bearing capacity up to 7 tons per sq. ft. Five thousand pounds per square foot of bearing area was therefore considered as a very conservative figure. The California Journal of Technology, from which the above note was taken, states that the experience obtained from structures that have been erected along the San Lorenzo River is such as to warrant a dependence being placed on the gravel strata for about 5,000 lbs. per sq. ft. of bearing area.

Method for Rapid Computation of Earthwork.—We are indebted to Mr. W. H. G. Mann, C. E., for the simple device, shown in the cut, for the rapid computation of the cubical contents of a cut or fill on railroad work. Regarding it Mr. Mann writes as follows: "It can be easily made, the writer having himself made

1. Found in California
 2. Cu. yds. in each
 3. Days of 100 ft.
 4. Found in California
 5. Cu. yds. in each
 6. Days of 100 ft.
 7. Found in California
 8. Cu. yds. in each
 9. Days of 100 ft.
 10. Found in California
 11. Cu. yds. in each
 12. Days of 100 ft.

(a)	(b)
8553	172
8187	174
7821	176
7455	178
7089	180
6723	182
6357	184
5991	186
5625	188
5259	190
4893	192
4527	194
4161	196
3795	198
3429	200
3063	202
2697	204
2331	206
1965	208
1599	210
1233	212
867	214
501	216
135	218
	220
	222
	224
	226
	228
	230
	232
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	300

numerous copies from the original, which was in the possession of a noted Canadian construction engineer. It should be made upon a portion of the same plate of profile paper as that in use on the work. The method of using it is as follows: Place the zero line of the card upon the grade line of the profile half-way between each 100-ft. station; read

the numbers appearing opposite the surface line in both columns a and b, placing them in position for adding up each column separately. Multiply the sum of the column a by the slope, the figures in that column being cubic yards in both slopes for a 1-to-1 ratio and 100 ft. long. Multiply the sum of the figures in column b by the width of roadbed, these figures being cubic yards in 100 ft. of bank, 1 ft. wide, with vertical slopes. Add the two results and the number of cubic yards in cut or fill is found, being as good an approximation as can be obtained from a profile, considering sections as level."

Cost of Topographical Survey.—The survey covered about 900 acres of rolling hills near San Antonio, Tex., the range of elevations being something over 100 ft. The ground was heavily wooded with mesquite brush. Three roads in each direction which had been previously staked and cleared, provided a skeleton for horizontal control. Levels were run from a distance of two miles and bench marks established at intervals of one-third of a mile along the roads, the profiles of the latter being taken simultaneously. The details were then filled in by random stadia lines, run by compass and with short courses in such a manner as to avoid clearing. No permanent marks were used at set up points and only the alternate points were occupied by the instrument. The whole survey was made by a party consisting of instrument-man and rod-man. Five foot contours were obtained and the tract was mapped on a scale of 200 ft. to the inch.

The itemized cost of the survey and mapping was as follows:

Field work:	Per	Total.	Acres.
Party of two, 7 days at \$7.20.....	\$50.10		
Labor extra.....	2.00		
Total	52.40	\$0.058	
Office work:			
1 latting and mapping, 1 man			
10 days.....	\$35.00		
Office expenses and materials.....	5.60		
Total	\$40.60	\$0.045	
Grand total.....	\$93.00	\$0.103	

For the above information we are indebted to Mr. Terrell Bartlett, C. E.

The use of canes for laths for plastering purposes is general throughout Spain; they are said to be durable and to give most satisfactory results. In Valencia bamboo cut into strips is also used; it is very strong, and holds the plaster well.

It is proposed to hold a cement rock products exhibit in Denver, Colo., Jan. 18-22, under the auspices of the National Cement & Plaster Association.

The Cost of a Dry Masonry Box Culvert.

Dry masonry box culverts have been used extensively in railroad construction, and their use will no doubt continue, especially where the haul of cement is long, as in new construction in mountainous sections of the country, also where the amount of work to be done does not justify the installation of a rock crusher. Records of cost of such work are, consequently, of value. We reprint the following from the Canadian Engineer.

Among the many classes of culverts constructed, none is more lasting than a well built dry masonry culvert. Where large stones with well defined faces can be secured, such as from rock cuttings on railroad work, these culverts can be built strong and with a very neat finish. Care should always be taken to secure good, firm bottom, and the foundation course should be placed well below the bed of the

lowed to slide and injure it. This was not charged against the culvert.

Equipment and Tools for Erecting Steel Bridges.

A committee of the Association of Railway Superintendents of Bridges and Buildings recommends the following list of tools for erecting steel spans and girders:

16 lb. sledges.

7 lb. hammers.

4 lb. hammers.

Snatch blocks.

Tackle blocks with lever for heavy loads, from one to three sheaves; shells from 8 ins. to 16 ins.

Manila rope from $\frac{5}{8}$ to $1\frac{1}{2}$ ins.

Hand made chains from $\frac{3}{4}$ to $1\frac{1}{4}$ ins., some with hook on one end and some with link on both ends, these to be made so one will pass through the other.

Steamboat ratchets.

Ball bearing and screw jacks.

Bar busters for cutting out rivets.
Handing busters for cutting out rivets.
Back out punches.
Drift pins.
Snaps or button sets.
Bar snaps.
Spring dolleys for holding up rivets.
Heel dolleys for holding up rivets.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0957. **Half a Century of Rope Making.**—A. Leschen & Sons Rope Co., St. Louis, Mo.

This 87-page book is a very handsome example of descriptive catalog work. The illustrations are among the finest we have ever seen, while the text describes rope making, rope tramway construction, underground rope haulage systems, and allied matters in great detail. There is in addition the usual catalog matter on sizes, strength, etc., etc. The pamphlet is worth securing and keeping on file.

No. 0958. **Derrick Swinging Machines.**—Read-Morrison Mfg. Co., Cambridge, Mass. This pamphlet shows cuts and describes briefly an interesting line of steam, electric and belt driven derrick swinging machines of various styles and sizes.

No. 0959. **Pelton Water Wheels.**—The Pelton Water Wheel Co., San Francisco and New York.

This pamphlet of over 100 pages is worthy of place in any library on hydraulics for the data it contains for computing hydraulic work. In addition full catalog information is given regarding Pelton wheels, a number of Pelton wheel power plants are described, and the principles and practice of impulse wheel power development are explained.

No. 0960. **Railway Grader and Spreaders.**—The Mann-McCann Co., Chicago, Ill.

This pamphlet illustrates by photographs and line drawings the McCann spreader and grader and the Mann spreader and grader, the Mann round-house smoke jacks, the Westinark flue rattler, the Rivelin system for wiring roundhouses, the Cleece railway trackmover and other special railway devices. Descriptive text points out the various features of the several devices and with the illustrations makes a useful catalog.

No. 0961. **Old Dominion Portland Cement.**—Wm. A. Hartman Co., Philadelphia, Pa.

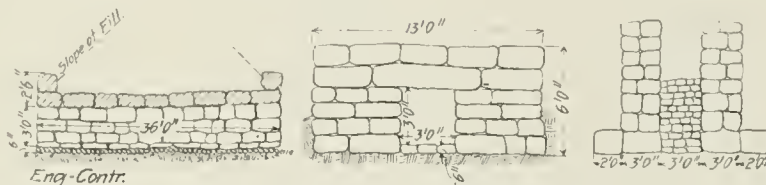
This pamphlet gives 95 pages of useful text interspersed with very handsome views of buildings and other structures in which the above named brand of cement has been used. The text comprises specifications, directions for testing cement and doing concrete work, and much other useful information.

No. 0962. **Steam Specialties.**—Western Kieley Steam Specialty Co., Chicago, Ill.

A full line of steam specialties including valves, traps, separators, controllers, regulators, heaters, pumps, etc., are listed in this 80-page pamphlet. Sectional drawings and full descriptions are given of many of the devices and all devices have prices, dimensions, etc., stated. The pamphlet contains several pages of useful tables, rules and instructions for steam fitters which make it well worth preserving.

No. 0963. **Hydrated Lime in Concrete and Cement Mortars.**—By E. W. Lazell, Ph. D., Charles Warner & Co., Philadelphia and New York.

The author discusses in this 16-page pamphlet principally the waterproofing effect on concrete and mortars of the addition of hydrated lime. The results of various tests are stated and discussed. Incidentally results are given of the effect of hydrated lime on strength, on the working quality of mortar, etc. The pamphlet is a strong presentation of the merits of hydrated lime for waterproofing concrete.



Sections of Dry Masonry Culverts.

stream, and thus prevent undermining of the walls. [The paving should not extend under the walls of the culvert, for should a part of the paving become misplaced, the small paving stones will be washed from under the walls, causing the latter to cave in and ruin the culvert. The lower course of stones should be as large as can be conveniently handled, so that heavy floods, that may injure the pavement will not misplace the wall stones.—Editors ENGINEERING-CONTRACTING.]

We give here the cost of a 3x3 ft. dry masonry culvert, 36 ft. long.

Excavation for foundation.....20 cu. yds.
Laborers, 22 hrs. at 20 cts..... 4.40

This gives a cost of 22 cts. per cu. yd. for excavation.

Masonry:

Mason, 60 hrs. at 40 cts.....\$24.00
Laborers, 130 hrs. at 20 cts..... 26.00
Team and teamster, 40 hrs. at 45 cts. 18.00
Derrick, 40 hrs. at 15 cts..... 6.00

Total\$74.00

The culvert contained 50 cu. yds. at a cost of \$74, or \$1.48 per cu. yd. The stone for this culvert was taken out of a rock dump 20 ft. away. Some of the large covers had to be handled 400 ft. The derrick used was the ordinary three leg derrick, legs 20 ft. long, and the derrick boom was 24 ft. long, one set reaching the full length of culvert, the derrick cable being operated by horse power, pulling through block and tackle.

When the dump reached the culvert, care was taken that large stones were not al-

Stone drills.
Ratchets—old men and drills.
Reamers.
Hack saws and frames.
Cape chisels.
Fluted chisels.
Handle chisels.
Claw bars.
Pinch bars.
Key wrenches.
Fitting up wrenches.
Socket wrenches.
Monkey wrenches.
Grind stone and grinding machine.
Cross cut saws.
Hand saws.
Adzes.
Augers.
Files.
Chopping axes.
Hand axes.
Timber trucks.
Cant hooks.
Carrying hooks.
Square.
Level.
Vise.
Pipe and Stilson wrenches.
Stocks and dies.
Shovels.
Picks.
Track gauge.
Drift pins—different sizes.
Rivet shears.
Girder hooks.
Stringer hooks.
Forges.
Rivet tongs.

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Nov. 11. Toledo, O.	Oct. 21
Nov. 11. Cleveland, O.	Oct. 21
Nov. 11. Whitefish Point, Mich.	Oct. 28
Nov. 11. Toledo, O.	Oct. 28
Nov. 11. Takoma Park, Md.	Nov. 4
Nov. 12. Charles City, Ia.	Oct. 21
Nov. 13. Cincinnati, O.	Oct. 28
Nov. 13. Cleveland, O.	Nov. 11
Nov. 16. Oakland, Cal.	Nov. 4
Nov. 17. Utica, S. Dak.	Oct. 28
Nov. 18. Marianna, Ark.	Oct. 28
Nov. 18. Forman, N. Dak.	Nov. 11
Nov. 20. Beaufort, N. C.	Oct. 28
Nov. 23. San Bernardino, Cal.	Nov. 11
Nov. 25. Richmond, Va.	Nov. 11
Nov. 25. Pittsburgh, Pa.	Nov. 11
Nov. 30. Havelock, N. B.	Nov. 4
Dec. 7. Lepreau, N. B.	Nov. 11
Dec. 7. Grenada, Miss.	Nov. 4
Dec. 7. Valparaiso, Ind.	Nov. 11

Buildings.

Nov. 11. Newbern, N. C.	Oct. 21
Nov. 11. Baltimore, Md.	Nov. 4
Nov. 11. Chicago, Ill.	Nov. 4
Nov. 12. Pittsburgh, Pa.	Nov. 11
Nov. 16. Iola, Kan.	Oct. 21
Nov. 16. Langston, Okla.	Nov. 4
Nov. 16. Youngstown, O.	Nov. 11
Nov. 16. New York, N. Y.	Oct. 14
Nov. 17. Crookston, Minn.	Nov. 11
Nov. 17. Tempe, Ariz.	Oct. 28
Nov. 18. Fort Hancock, N. J.	Oct. 14
Nov. 19. Rawlins, Wyo.	Nov. 4
Nov. 19. La Jara, N. Mex.	Nov. 11
Nov. 19. Pittsburgh, Pa.	Oct. 21
Nov. 20. Trinidad, Col.	Nov. 4
Nov. 20. Soldiers Home, Cal.	Nov. 4
Nov. 20. Utica, N. Y.	Nov. 11
Nov. 20. Atlantic City, N. J.	Nov. 11
Nov. 20. Bemidji, Minn.	Oct. 28
Nov. 21. Philadelphia, Pa.	Nov. 4
Nov. 21. Crow Creek Agency, S. Dak.	Nov. 11
Nov. 21. Oxford, O.	Nov. 11
Nov. 21. Washington, D. C.	Oct. 28
Nov. 23. Ship Island, Miss.	Nov. 11
Nov. 23. Alfred, N. Y.	Nov. 11
Nov. 23. Chicago, Ill.	Nov. 11
Nov. 23. Chicago, Ill.	Nov. 11
Nov. 23. Chicago, Ill.	Oct. 21
Nov. 24. Baker City, Ore.	Oct. 28
Nov. 25. Hazelton, Pa.	Nov. 11
Nov. 25. Oakland, Cal.	Oct. 28
Nov. 27. Milford, Del.	Nov. 11
Nov. 27. Cincinnati, O.	Oct. 28
Nov. 30. Manchester, Va.	Oct. 28
Dec. 1. Newton, Kan.	Nov. 11
Dec. 1. Washington, D. C.	Oct. 28
Dec. 2. Carlisle, Pa.	Oct. 28
Dec. 7. Lebanon, Ind.	Nov. 4
Dec. 8. Gainesville, Ga.	Nov. 4

Roads and Streets.

Nov. 11. Chicago, Ill.	Nov. 4
Nov. 11. Chicago, Ill.	Nov. 4
Nov. 13. St. Louis, Mo.	Nov. 4
Nov. 13. Valparaiso, Ind.	Oct. 28
Nov. 14. Cleveland, O.	Nov. 11
Nov. 16. Muskogee, Okla.	Nov. 11
Nov. 16. Lansford, N. Dak.	Nov. 11
Nov. 17. Chicago, Ill.	Nov. 11
Nov. 18. Brooklyn, N. Y.	Nov. 11
Nov. 18. Opelousas, La.	Nov. 4
Nov. 20. York, Pa.	Nov. 4
Nov. 20. Clearfield, Pa.	Oct. 28
Nov. 20. Wabash, Ind.	Nov. 11
Nov. 20. Clearfield, Pa.	Nov. 11
Nov. 23. Ste. Emile, Que.	Nov. 4

Nov. 23. East Liverpool, O.	Nov. 11
Nov. 25. Uniontown, Pa.	Nov. 11
Nov. 27. Cincinnati, O.	Nov. 11
Nov. 27. Columbus, O.	Nov. 11
Nov. 27. Cincinnati, O.	Nov. 11

Sewers.

Nov. 12. Cleveland, O.	Nov. 4
Nov. 12. Fargo, N. Dak.	Nov. 4
Nov. 12. Grand Rapids, Mich.	Nov. 11
Nov. 12. Fort Wayne, Ind.	Nov. 11
Nov. 14. Seattle, Wash.	Nov. 4
Nov. 14. Kearney, Neb.	Nov. 11
Nov. 14. Decatur, Ill.	Nov. 11
Nov. 16. Hartwell, O.	Nov. 4
Nov. 16. Fort Dodge, Ia.	Nov. 4
Nov. 16. Washington, D. C.	Nov. 4
Nov. 16. Washington, D. C.	Nov. 11
Nov. 16. De Pere, Wis.	Nov. 11
Nov. 16. Albany, N. Y.	Nov. 11
Nov. 16. Wellington, Kan.	Nov. 11
Nov. 16. Washington, D. C.	Nov. 11
Nov. 16. Tuskegee, Ala.	Nov. 11
Nov. 18. Steubenville, O.	Nov. 11
Nov. 18. Rye, N. Y.	Nov. 11
Nov. 20. Dayton, O.	Nov. 4
Nov. 21. Roanoke, Va.	Nov. 4
Nov. 23. East Rutherford, N. J.	Nov. 11
Dec. 1. Guayaquil, Ecuador	Oct. 7

Water Supply.

Nov. 12. Toledo, O.	Oct. 21
Nov. 12. Gadsden, Ala.	Oct. 28
Nov. 12. San Diego, Cal.	Oct. 28
Nov. 12. Fargo, N. Dak.	Nov. 4
Nov. 14. National Military Home, Ind.	Nov. 11
Nov. 16. Hartwell, O.	Oct. 21
Nov. 16. Lamar, Colo.	Nov. 4
Nov. 17. Spirit Lake, Ia.	Nov. 4
Nov. 18. Fort Robinson, Neb.	Nov. 11
Nov. 18. Chicago, Ill.	Nov. 11
Nov. 23. Wilmington, Del.	Oct. 21
Nov. 23. Pittsburg, Pa.	Nov. 11
Nov. 23. Las Animas, Colo.	Nov. 11
Nov. 24. Meridian, Miss.	Nov. 4
Nov. 24. Pensacola, Fla.	Nov. 4
Nov. 24. Wensatchee, Wash.	Nov. 4

Miscellaneous.

Nov. 11. Chicago, Ill.	Transmission Lines, Nov. 4
Nov. 11. Chicago, Ill.	Concrete Work, Excavation, Nov. 4
Nov. 12. Cleveland, O.	Retaining Wall, Nov. 4
Nov. 13. Cape St. Ignace, Que.	Wharf, Oct. 28
Nov. 13. West Advocate, N. S.	Breakwater, Nov. 4
Nov. 13. Quaco, N. B.	Pier Extension, Nov. 4
Nov. 14. Charleston, S. C.	Coal Handling Plant, Oct. 21
Nov. 14. Peterboro, Ont.	Canal Work, Oct. 28
Nov. 14. Evansville, Ind.	Street Sweeping, Nov. 11
Nov. 16. Ottawa, Ont.	Wharf, Pier Extension, Oct. 28
Nov. 16. Riviere Blanche, Que.	Pier Head Extension, Nov. 4
Nov. 16. Pointe a Brousseau, Que.	Wharf, Nov. 4
Nov. 17. Mobile, Ala.	Lock and Dam, Sept. 23
Nov. 17. New York, N. Y.	Borings, Oct. 28
Nov. 17. Albany, N. Y.	Canal Work, Oct. 28
Nov. 17. Philadelphia, Pa.	Street Lighting, Nov. 11
Nov. 18. California City Point, Cal.	Coal Hoisting Tower, Oct. 14
Nov. 18. Fort Myer, Va.	Fences, Corrals, Oct. 28
Nov. 18. Plattsburg Barracks, N. Y.	Electric Light System, Oct. 28
Nov. 18. Chicago, Ill.	Cable Work, Nov. 11
Nov. 18. Chicago, Ill.	Concrete Work, Excavation, Nov. 11
Nov. 19. San Francisco, Cal.	Pier and Shed, Oct. 28
Nov. 19. Gendreau, Que.	Dam, Bulkheads, Etc., Nov. 4
Nov. 19. Devil's Island, N. S.	Breakwater Extension, Nov. 11
Nov. 19. Chicago, Ill.	Dock Work, Nov. 11
Nov. 19. San Francisco, Cal.	Sea Wall, Nov. 11
Nov. 20. Mobile, Ala.	Pump Dredge, Oct. 21
Nov. 21. Cleveland, O.	Vacuum Cleaning System, Nov. 4
Nov. 23. Pelee Island, Ont.	Wharf Extension, Nov. 4
Nov. 24. Johnstown, Pa.	Electric Lighting, Nov. 11
Nov. 27. Michipicoten, Ont.	Wharf, Nov. 4
Nov. 27. Three Rivers, Que.	Dock and Ice Breaker, Nov. 11

Nov. 28. St. Louis, Mo.	Dry Dock, Oct. 28
Nov. 30. Lepreau, N. B.	Retaining Wall, Nov. 11
Dec. 1. Fort Robinson, Neb.	Electric Light System, Etc., Nov. 11
Dec. 2. Fort Sam Houston, Tex.	Electric Light Line Extension, Nov. 11
Dec. 12. Chicago, Ill.	Pile Pier, Nov. 4
Dec. 15. Washington, D. C.	Steam Collier, Nov. 4

Excavation, Earth and Rock

Nov. 11. Northwood, Ia.	Drainage Work, Oct. 21
Nov. 11. Estherville, Ia.	Ditch Work, Oct. 28
Nov. 14. Galveston, Tex.	Dredging, Oct. 21
Nov. 14. Burlington, Ia.	Drainage Work, Nov. 4
Nov. 14. Barstow, Tex.	Drainage System, Nov. 11
Nov. 14. Walsenburg, Colo.	Ditch, Nov. 11
Nov. 14. Corning, Ark.	Ditch Work, Nov. 11
Nov. 16. Stonington, Ill.	Tile Drains, Nov. 4
Nov. 16. Ottawa, Ont.	Dredging, Nov. 11
Nov. 17. Paragould, Ark.	Ditch Work, Nov. 4
Nov. 17. Rockwell City, Ia.	Ditch Work, Nov. 11
Nov. 17. Paragould, Ark.	Ditch Work, Nov. 11
Nov. 20. Cincinnati, O.	Embankment, Nov. 11
Nov. 20. Warren, Minn.	Ditch Work, Nov. 11
Nov. 20. Eldora, Ia.	Tile Drain, Nov. 11
Nov. 23. Sibley, Ia.	Ditch, Tile Work, Nov. 11
Nov. 30. Los Angeles, Cal.	Ditch Work, Oct. 21
Dec. 1. Hawaii	Dredging, Sept. 23

Materials, Machines, Supplies, Tools, Etc.

Nov. 11. Washington, D. C.	Marble Columns, Oct. 28
Nov. 11. Chicago, Ill.	Electric Light Cable, Nov. 4
Nov. 12. Milwaukee, Wis.	Water Pipe, Nov. 4
Nov. 13. Frankfurt, Ind.	Electrical Machinery, Nov. 11
Nov. 16. Washington, D. C.	Unloading Cranes, Oct. 28
Nov. 16. Columbus, O.	Garbage Plant, Nov. 11
Nov. 17. Warren, Pa.	Engines, Pumps, Nov. 4
Nov. 17. Annapolis, Md.	Surface Condensing Plant, Nov. 11
Nov. 18. San Francisco, Cal.	Pumps, Turbines, Nov. 11
Nov. 19. Grand Rapids, Mich.	Pumping Engine, Nov. 11
Nov. 20. Fort McIntosh, Tex.	Boiler, Heater, Etc., Nov. 4
Nov. 21. Chicago, Ill.	Freight Elevators, Nov. 11
Nov. 21. Boston, Mass.	Air Compressor, Nov. 11
Nov. 21. Mare Island, Cal.	Air Compressor, Nov. 11
Nov. 23. Pittsburgh, Pa.	Filter Plant Equipment, Nov. 11
Nov. 24. Meridian, Miss.	Pumping Engines, Nov. 4
Nov. 24. Pekin, Ill.	Boilers, Pumps, Etc., Nov. 4
Nov. 24. Augusta, Ga.	Pump, Power Plant, Nov. 11
Nov. 27. Grand Rapids, Mich.	Sewage Pumping Machinery, Nov. 11
Nov. 27. Washington, D. C.	Steel Dump Cars, Nov. 11
Nov. 28. Denver, Colo.	Freight Lift, Nov. 11
Nov. 30. Atlanta, Ga.	Motor, Nov. 11

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

San Bernardino, Cal.—Until Nov. 23, by County Supervisors, for constructing 30-ft. I-beam bridge over Missouri Storm Drain on Colton Ave.

Chicago, Ill.—See under Bids Asked—Miscellaneous.

Valparaiso, Ind.—Until noon, Dec. 7, by S. P. Corboy, County Auditor, for following

steel bridges. One 40-ft. span on concrete; one 60-ft. span on tubes; one 100-ft. span on tubes and two 90-ft. spans on tubes. G. F. Stinchfield, County Surveyor.

Forman, N. Dak.—Until 2 p. m., Nov. 18, by R. P. Irvine, County Auditor, for erection of a 20-ft. long, 18-in. wide steel bridge, a 24-ft. long, 16-ft. wide steel bridge and 28-ft. long, 18-in. wide steel bridge.

Cleveland, O.—Until Nov. 13, by A. R. Callow, Secretary Board Public Service, for constructing culvert in ravine crossing E. 90th St.

Pittsburg, Pa.—Until 2 p. m., Nov. 25, by F. P. Booth, County Controller, for constructing bridge over Monongahela River for Allegheny and Washington Counties. W. Wylie, Washington, Pa., is County Engineer.

Utica, S. Dak.—Until Nov. 17, according to reports, by W. J. Hladky, Township Clerk for building two bridges in Utica Township.

Richmond, Va.—Until Nov. 25, by State Highway Commissioner, Richmond, for constructing steel and reinforced concrete bridge over Chickahominy River near Hanover.

Lepreau, N. B.—Until noon, Nov. 30, by John Morrissy, Chief Commissioner, Department Public Works, Fredericton, N. B., for rebuilding Mill Pond bridge over Little Lepreau River at Hanson's.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Tempe, Ariz.—Until Nov. 17, by J. O. Mullen, Clerk, for constructing new high school building.

Oakland, Cal.—Until 10 a. m., Nov. 25, by Board Public Works, Walter B. Fawcett, Secretary, for erecting three fire engine houses for the Fire Department.

Washington, D. C.—Until 2 p. m., Nov. 21, by Bernard R. Green, Superintendent of Construction, Office of Building for National Museum, Library of Congress, Washington, for furnishing, delivering and installing in place complete the white marble wainscoting, partitions and tiling of halls and lavatories and the Tennessee marble tiling, stairs, strings and bases, etc., required in the new building for the National Museum in this city.

Washington, D. C.—Until noon, Dec. 1, by H. L. Pettus, Constructing Q. M., Takoma Sub-Station, Washington, for completion of fourth floor, installing electric elevators and vacuum cleaning system at the Walter Reed Army General Hospital, Washington.

Chicago, Ill.—Until 11 a. m., Nov. 23, by John J. Hanberg, Commissioner Public Works, 202 Randolph St., for furnishing all labor, materials and appliances necessary to construct a public bath house at W. 20th St., near Lincoln St., according to plans and specifications on file in the Bureau of Architecture, 4th floor, 117 Market St.

Chicago, Ill.—Until 1:30 p. m., Nov. 23, by County Commissioners, William McLaren, Superintendent Public Service, 519 Cook County Court House, for erection of county infirmary at Oak Forest, 18 miles from Chicago. Building will cost about \$2,000,000, it is said. Holabird & Roche, Architects, 1618 Monadnock Bldg.

Chicago, Ill.—Until 2 p. m., Nov. 23, by Board of Inspectors, House of Correction, 26th St. and California Ave., for the structural iron and cell work required for the construction of the new cell house. Plans, etc., with City Architect, 117 Market St., or the Superintendent of the House of Correction.

Bemidji, Minn.—Until 4 p. m., Nov. 20, by A. R. Ritchie, Secretary, for general contract for erection of a Carnegie library, Haxby & Gillespie, Architects, Fargo, N. Dak.

Atlantic City, N. J.—Until 2 p. m., Nov. 20, by S. I. Kimball, General Superintendent, U. S. Life Saving Service, Washington, D. C., for the construction of a lifeboat house and launchway at the Atlantic City, N. J., Life Saving Station.

Alfred, N. Y.—Until 2 p. m., Nov. 23, by Dr. Boothe C. Davis, President Board of Managers of Alfred University, for construction, complete, including heating, plumbing, gas piping and fixtures for barn and dairy house at State School of Agriculture, Alfred University, Franklin B. Ware, State Architect, Albany, N. Y.

New York, N. Y.—Until 3:30 p. m., Nov. 16, by C. B. J. Snyder, Superintendent of School Buildings, for forming classrooms on 5th floor of Public School 184, and for additions, repairs and alterations to heating apparatus in Public School 14.

Cincinnati, O.—Until 2 p. m., Nov. 27, by Col. William T. Rossell, U. S. Engrs., for

building a warehouse at Dam No. 37, Ohio River.

Oxford, O.—Until noon, Nov. 21, by Trustees Miami University, O. V. Parrish, Secretary Building Committee, for erection of a building for normal school purposes, Franklin L. Packard, Architect, Columbus, O.

Youngstown, O.—Until noon, Nov. 16, by Board of Education, W. N. Ashbaugh, Clerk, 29 W. Federal St., for installing heating, ventilating and sanitary apparatus in the Fairmont Ave. school.

Pittsburg, Pa.—Until 10:30 a. m., Nov. 12, by Edward G. Lang, Director Department of Public Safety, for alterations, repairs and improvements to engine house No. 3, 7th Ave.

Pittsburg, Pa.—Until 10 a. m., Nov. 19, by James P. Shaw, Director of Charities and Correction, for construction of a hospital building at Marshalsea, Kiehnel & Elliott, Architects, 209 Ninth St., Pittsburg.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Chicago, Ill.—Until 11 a. m., Nov. 17, by Department Public Works, John J. Hanberg, Commissioner, for labor and material for paving with asphalt and curbing with concrete combined curb and gutter in Lawrence Ave., from Evanston Ave. to C. & E. Ry. tracks.

Valparaiso, Ind.—Until 7 p. m., Nov. 13, by C. D. Jones, City Clerk, on 16,148 sq. yds. brick pavement, 9,260 lin. ft. combined curb and gutter and 488 lin. ft. headers. Certified check for \$500 required with bid. G. F. Stinchfield, City Engineer.

Opelousas, La.—Until Nov. 18, by Mayor M. Halphen, for constructing 6,975 ft. of 5-ft. cement sidewalk.

Lansford, N. Dak.—Until 8 p. m., Nov. 16, by W. S. Todd, City Auditor, for graveling two blocks in 3rd Ave.

Brooklyn, N. Y.—Until 11 a. m., Nov. 18, by Bird S. Coler, Borough President, for several contracts for regulating, grading, curbing and laying sidewalks; also for regulating and paving with asphalt.

Cincinnati, O.—Until Nov. 27, by County Commissioners, Fred Dreihls, Clerk, for work under Specification No. 826—treatment of Ohio Pike in Anderson Township.

Cincinnati, O.—Until Nov. 27, by County Commissioners, Fred Dreihls, Clerk, for work under Specification No. 824, for repairing Springfield Pike in Springfield Township.

Columbus, O.—Until 2 p. m., Nov. 27, by County Commissioners, John Scott, Clerk, for repairing portion of W. 5th Ave., the work including 2,400 tons crushed limestone furnished, hauled, spread and rolled.

East Liverpool, O.—Until noon, Nov. 23, by Board Public Service, A. S. Hughes, Clerk, for grading and paving with hard burned vitrified fire brick, and constructing necessary curbs, sewers, gutters and drains in part of Pennsylvania Ave. Bids are also asked for similar improvement of part of Sheridan Ave. Certified check for \$500 for each street required with bid.

Muskogee, Okla.—Until Nov. 16, by L. B. Kinsey, City Engineer, for 300,000 sq. yds. asphalt paving.

Clearfield, Pa.—Until Nov. 20, by State Highway Department, Harrisburg, Pa., for constructing following brick roads in Clearfield County: Curwensville Borough, 3,135 ft. of 16-ft. wide road; Clearfield Borough, 2,940 ft. of 16-ft. wide road.

Uniontown, Pa.—Until Nov. 25, by State Highway Department, Harrisburg, Pa., for constructing 6,654 ft. of state road in South Union Township, and 26,100 ft. of road in Menallen Township.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Tuskegee, Ala.—Until 3 p. m., Nov. 16, by Mayor O. S. Lewis, for labor and materials for constructing 3,755 lin. ft. 8-in. and 1,529 lin. ft. 6-in. pipe sewer, G. N. Mitcham, Engineer.

Washington, D. C.—Until noon, Nov. 16, by District Commissioners, 427 District Bldg., for constructing trunk sewers.

Decatur, Ill.—Until 2 p. m., Nov. 14, by Board Local Improvements, for constructing lateral sewer.

Fort Wayne, Ind.—Until 7:30 p. m., Nov. 12, by Board Public Works, H. W. Becker, Clerk, for constructing several vitrified clay pipe sewers.

Wellington, Kan.—Until 8 p. m., Nov. 16, by A. B. Cheever, City Clerk, for material and constructing sewers in District No. 3; also for constructing main intercepting sewer from corner of 10th and H Sts. to outlet at State Creek. Certified check for \$500 required with bid. H. A. Rowland, Engineer, McPherson, Kan.

Grand Rapids, Mich.—Until 8 p. m., Nov. 12, by Board Public Works, S. A. Freshney, Secretary, for furnishing and erecting a sewage pumping station on the West Side Ditch Sewer. Bids for the pumps are now being asked, as stated elsewhere in this issue.

Fort Robinson, Neb.—See under Bids Asked—Water Supply.

Kearney, Neb.—Until Nov. 14, by Geo. E. Ford, City Clerk, for constructing an 8-in. pipe sewer.

East Rutherford, N. J.—Until 8 p. m., Nov. 23, by Council Sewer Committee, for the completion of all the works remaining to be completed for the construction of the system of sewers and sewage disposal plants for this Borough mentioned and specified in a certain contract recently abandoned. Wise & Watson, Borough Engineers, Rutherford, N. J.

Albany, N. Y.—Until 3 p. m., Nov. 16, by Board of Contract and Supply, Isidore Wachsman, Clerk, for constructing 12-in. vitrified stoneware pipe sewer in Whitehall St. Bond for \$500 required with bid.

Rye, N. Y.—Until 8 p. m., Nov. 18 (readvertisement) by Village Clerk, for labor and materials for constructing sanitary sewers and sewage disposal plant. Work includes about 90,000 ft. of vitrified pipe sewers, 5-in. to 18-in. laid complete, with manholes and flush tanks, much of it in rock excavation; 12,600 ft. of iron pipe sewers, siphons and force main, 4-in. to 16-in.; 1,200 ft. of subaqueous iron effluent outlet into Long Island Sound; indeterminate amount of agricultural drain tile laid in sewer trench; two small pumping stations complete; sewage tanks, and coke filter beds, with appurtenances; considerable but indeterminate amount of piling and earthwork. G. Everett Hill, Engineer, 156 Fifth Ave., New York.

Dayton, O.—Until noon, Nov. 20, by Board Public Service, W. A. Budroe, Clerk, for constructing storm water sewers as follows: In Stewart St., to include 490 lin. ft., 20-in., 330 lin. ft., 18-in., etc.; across lands of the Society of Mary, to include 650 lin. ft. of 24-in. vitrified pipe; in Alberta, Union and Stewart Sts., to include 1,335 lin. ft., 36-in. concrete sewer, 350 lin. ft., 22-in. vitrified pipe sewer, etc.

Steubenville, O.—Until noon, Nov. 18, by Board Public Service, H. G. Simpson, Clerk, for constructing vitrified pipe sewer in 6th Ave. and in 9th St.

De Pere, Wis.—Until 4 p. m., Nov. 16, by Committee on Streets, care City Clerk, for laying 900 ft. of 30-in. pipe sewer.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Las Animas, Colo.—Until 2 p. m., Nov. 23 (change of date), by Ida Z. Loudy, Town Clerk, for furnishing material and labor and constructing water works improvements as follows: Complete new pumping plant, including building and equipment; steel tank or standpipe; extensions and additions to present mains, approximating 23,000 lin. ft. cast-iron pipe. W. R. Murphy, Town Engineer, Las Animas, Colorado. The W. K. Palmer Co., Consulting Engineers, Dwight Bldg., Kansas City, Mo.

Chicago, Ill.—Until 11 a. m., Nov. 18, by Board Local Improvements, C. A. V. Standish, Secretary, for five contracts for constructing water supply pipes and seven contracts for water service pipes.

National Military Home, Ind.—Until Nov. 14, by J. W. Sanderson, Treasurer Marion Branch, N. H. D. V. S., National Military Home, for installation of a water softening and purifying plant.

Fort Robinson, Neb.—Until 1 p. m., Nov. 18, by Capt. F. T. Arnold, Constructing Q. M., for furnishing materials and labor for the construction of additions to water and sewerage systems at this post.

Pittsburg, Pa.—Until 10 a. m., Nov. 23, by A. B. Shepherd, Director Public Works, for cleaning the interior surface of about 1,960 lin. ft. of 8-in. cast-iron water main and about 8,409 lin. ft. of 6-in. water main, in its present position.

Pittsburg, Pa.—Until noon, Nov. 23, by Bureau of Filtration, for work in connection with equipment of the extension of the city filter plant. See under Bids Asked—Materials.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Corning, Ark.—Ditch Work.—Until Nov. 14, by Directors Western Clay Drainage District, Chas. W. Jones, Secretary, for constructing main ditch and laterals, requiring 725,000 cu. yds. excavation. J. D. Mitchell, Greenway, Ark., is Engineer.

Paragould, Ark.—Ditch Work.—Until 11 a. m., Nov. 17, at County Court House, for constructing nine-mile ditch to straighten Eight Mile Creek in Cache River Drainage District No. 1. Work requires about 435,500 cu. yds. excavation. Lund & Hill, Engineers, Little Rock, Ark.

Walsenburg, Colo.—Ditch.—Until Nov. 14, by T. W. Jaycox, State Engineer, Denver, Colo., for constructing 2,400 lin. ft. of drainage ditch for diverting flood waters from this town.

Eldora, Ia.—Tile Drain.—Until noon, Nov. 20, by R. A. Vigers, County Auditor, for constructing tile drain and lateral branches in Drainage District No. 7. Main drain includes 10,200 ft. 10-in. to 26-in. tile, at average depth of 6½ ft. Laterals include 8,700 ft. of 12-in. to 18-in. tile at average depth of 5½ ft.

Rockwell City, Ia.—Ditch Work.—Until noon, Nov. 17, by B. E. Stonebraker, County Auditor, for constructing Ditch No. 83 the work including 69,000 lin. ft. tile work and 262,950 cu. yds. excavation.

Sibley, Ia.—Ditch, Tile Work.—Until noon, Nov. 23, by V. A. Burley, County Auditor, for constructing ditch, requiring about 29,500 ft. of tile work, and 5,800 ft. of open work.

Warren, Minn.—Ditch Work.—Until 2 p. m., Nov. 20, by P. B. Malberg, County Auditor, for constructing Ditch No. 16, requiring 57,464 cu. yds. of excavation.

Cincinnati, O.—Embankments.—Until Nov. 20, by County Commissioners, Fred Drehs, Clerk, for constructing embankments on New Richmond Pike at Four, Five and Eight Mile Creeks, in Anderson Township.

Barstow, Tex.—Drainage System.—Until 9 a. m., Nov. 14, by T. B. Anderson, Chairman Commissioners, for constructing drainage system.

Ottawa, Ont.—Dredging.—Until 4:30 p. m., Nov. 16, by Nap. Tessier, Secretary Department Public Works, Ottawa, for dredging required in the Middle Channel, in the River St. Lawrence, between Kingston and Brockville, in the Province of Ontario. Certified check for \$10,000 required with bid.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

San Francisco, Cal.—Sea Wall.—Until 3 p. m., Nov. 19, by State Harbor Commissioners, W. B. Thorpe, Secretary, Ferry House, for material and constructing Sec. 11 of sea wall for 600 ft. Work will require about 55,000 tons of stone.

Chicago, Ill.—Cable Work.—Until noon, Nov. 18, by Trustees Sanitary District of Chicago, O. J. Bryan, Clerk, 1500 American Trust Bldg., Chicago, for work under Division A—installing and connecting cables.

Chicago, Ill.—Concrete Work, Excavation.—Until noon, Nov. 18 (postponement from Nov. 11), by Trustees Sanitary District of Chicago, I. J. Bryan, Clerk, American Trust Bldg., for work on Sec. 12 of North Shore Channel. The work includes the excavation of about 150,000 cu. yds. of earth, the building of a reinforced concrete dam on the North Branch of the Chicago River, the construction of substructures and the erection only of the superstructures of highway bridges at Foster Ave., Argle St. and Lawrence Ave.

Chicago, Ill.—Dock Work.—Until 11 a. m., Nov. 19, by Department Public Works, Paul Redieske, Deputy Commissioner, for the removal of 30 ft., more or less, of old dock and the construction of about 96 ft., more or less, of new dock on east side of north branch, Chicago River, on Ogden canal, at foot of North Branch.

Evansville, Ind.—Street Sweeping.—Until Nov. 14, by Board Public Works, Walter F. Wunderlich, Clerk, for sweeping and cleaning brick, asphalt and block streets during 1909.

Fort Robinson, Neb.—Electric Light System, Etc.—Until 1 p. m., Dec. 1, by Capt. F. T. Arnold, Constructing Q. M., for constructing an electric lighting system, building for transformer sub-station, and fur-

nishing electric current for illuminating and small motor purposes at this post.

Johnstown, Pa.—Electric Lighting.—Until Nov. 24, by G. E. Hamilton, City Clerk, for electric lighting for period of five or ten years.

Philadelphia, Pa.—Street Lighting.—Until noon, Nov. 17, by George R. Stearns, Director Public Works, for lighting the incandescent naphtha lamps and furnishing lamp-posts in the city of Philadelphia during year 1909. Specifications, etc., at the office of the Bureau of Lighting, Room No. 334, City Hall.

Fort Sam Houston, Tex.—Electric Light Line Extension.—Until 11 a. m., Dec. 2, by L. J. Fleming, Constructing Q. M., for the construction of an extension to the electric light lines and additional street lights at this post.

Lepreau, N. B.—Retaining Wall.—Until noon, Nov. 30, by John Morrissy, Chief Commissioner, Department Public Works, Fredericton, N. B., for rebuilding brickyard cove retaining wall on Little Lepreau Road, parish of Lepreau, Charlotte County, N. B.

Devil's Island, N. S.—Breakwater Extension.—Until 4:30 p. m., Nov. 19, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for extension of breakwater at Devil's Island.

Three Rivers, Que.—Dock and Ice Breaker.—Until 4:30 p. m., Nov. 27, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for construction of timber dock and ice breaker at Three Rivers.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Mare Island, Cal.—Air Compressor.—Until 11 a. m., Nov. 21, by Bureau Yards and Docks, Washington, D. C., for furnishing and installing a 5,000 cu. ft. air compressor and accessories at Navy Yard, Mare Island.

San Francisco, Cal.—Pumps, Turbines.—Until Nov. 18, by Board Public Works, for pumps and turbines for the fire protection system and for the salt water pumping stations. M. Manson, City Engineer.

Denver, Colo.—Freight Lift.—Until 3 p. m., Nov. 28, by James Knox Taylor, Supervising Architect, Washington, D. C., for the installation of a hydraulic freight lift in the U. S. Court House and Postoffice, Denver.

Washington, D. C.—Steel Dump Cars.—Until Nov. 27, by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing four steel dump cars, under Circular 477.

Atlanta, Ga.—Motor.—Until 10 a. m., Nov. 30, by R. V. LeDow, Superintendent of Prisons, Department of Justice, Washington, D. C., for furnishing and delivering at U. S. Penitentiary, Atlanta, a 25 HP. electric motor and material.

Augusta, Ga.—Pump, Power Plant.—Until 4 p. m., Nov. 24, by Nisbet Wingfield, City Engineer, for furnishing and erecting a pumping engine of 6,000,000 gallons daily capacity and a steam plant of 450 HP.

Frankfort, Ind.—Electrical Machinery.—Until Nov. 13, by Worth Price, City Clerk, for furnishing one 300 KW. turbine and generator, complete with all necessary apparatus thereto; condensers to condense steam from 500 and 300 KW. generators; also motors to run street light machine and all other necessary machinery and auxiliary apparatus.

Boston, Mass.—Air Compressor.—Until 11 a. m., Nov. 21, by Bureau Yards and Docks, Washington, D. C., for furnishing and installing a 5,000 cu. ft. air compressor and accessories at Navy Yard, Boston, Mass.

Annapolis, Md.—Surface Condensing Plant.—Until Nov. 17, by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing at the Naval Academy, Annapolis, a surface condensing plant. Schedule 530.

Grand Rapids, Mich.—Pumping Engine.—Until 8 p. m., Nov. 19, by Board Public Works, S. A. Freshney, Secretary, for the construction, delivery and erection at the

water works pumping station of one vertical triple-expansion pumping engine, having a normal capacity of twelve million U. S. gallons of water in 24 hours. L. W. Anderson, City Engineer.

Grand Rapids, Mich.—Sewage Pumping Machinery.—Until 8 p. m., Nov. 27, by Board Public Works, S. A. Freshney, Secretary, for sewage pumping station machinery consisting in general of four 40-in., four 24-in. and two 18-in. centrifugal pumps; four 175-HP., two 75-HP., two 60-HP. and three 30-HP. electric motors, together with vacuum pumps, piping, etc. L. W. Anderson, City Engineer.

Columbus, O.—Garbage Plant.—Until Nov. 16, by Board Public Service, for furnishing machinery and equipment for the reduction of garbage.

Pittsburg, Pa.—Filter Plant Equipment.—Until noon, Nov. 23, by Bureau of Filtration, Municipal Hall, for furnishing and installing equipment for the extension of the city filtration work. Work consists of Contract 11A—electrical equipment—consisting of power and lighting circuits in 10 filter beds and one gallery; Contract 11B—sand washer system, including 20,000 lin. ft. 3 in. to 12 in. lap welded steel pipe, etc.; Contract 11C—inlet controlling valves, furnishing and installing 10; Contract 11D—outlet rate controlling valves, furnishing and installing 10; Contract 11E—indicator and recording apparatus; Contract 11F—heating and ventilating apparatus; Contract 11G—transfer trucks and turntables; Contract 11H—filter materials; Contract 11J—sluice gates.

Charleston, S. C.—Freight Elevators.—Until 11 a. m., Nov. 21, by Bureau Yards and Docks, Washington, D. S., for furnishing and installing two freight elevators at Navy Yard, Charleston.

CONTRACTS LET.

The following contracts have been let recently:

Argenta, Ark.—Sewer.—J. H. Ellis, of Ellis Hardware & Plumbing Co., for constructing 1,300 ft. of private sewer.

Paris, Ark.—Court House.—Halter Bros., Conway, Ark., at about \$40,000, for constructing new county court house.

Oakland, Cal.—Wrecking Building.—Pacific Construction Co., at \$8,857, for tearing down old county jail.

Redondo, Cal.—Pump and Motor.—California Ornamental Brick Co., Los Angeles, at \$2,086, for pump and motor for new sewer system.

San Bernardino, Cal.—Bridges.—C. G. Sheeley Co., Denver, Colo., at \$8,712, for constructing 200-ft. span steel bridge over Mojave River at Barstow; Union Iron Works, Los Angeles, at \$1,881, for bridge over City Creek on Highland Ave.

Hopefield, Ark.—Terminal Yards.—Dalhoff Construction Co., Little Rock, Ark., has contract for constructing terminal tracks, round house and coal chute at Hubert, for C. R. I. & P. Ry.

Hartford, Conn.—Sewer.—John Ferrante, at \$1,018, for constructing sewer in Vine St.

Wilmington, Del.—Removing Wreck.—Eugene Boehm, Atlantic City, N. J., for removing wreck of steamer Gulf Stream lying sunk at entrance to Hereford Inlet, New Jersey. Other bids received by Capt. L. H. Rand, U. S. Engrs., were as follows: Merritt & Chapman Derrick & Wrecking Co., 17 Battery Pl., New York, \$9,860; Van Sant & Gandy, Atlantic City, N. J., \$4,682; Napoleon B. Register, Lewes, Delaware, \$3,813; Johnston & Virden, Lewes, Delaware, \$1,540; Frank R. Jones, Wilmington, Del., \$4,400; Jesse A. Gray, Philadelphia, Pa., \$1,950.

Council Bluffs, Ia.—Auditorium.—Wickham Bros., for erection of new auditorium here.

Waterloo, Ia.—Cement Walk.—Mishler & Ryan, Waterloo, for constructing about 10 miles of cement walk.

East St. Louis, Ill.—Brick Paving.—Following bids were received Oct. 31 by this city for paving portion of 26th St. with brick, (1) standing for Keeley & Gaynard, (2) for W. H. Hill, (3) for Myers Construction Co., and (4) for Water Coonan:

	(1)	(2)	(3)	(4)
15-in. drain pipe laid, 240 ft.....	\$0.70	\$0.68	\$0.75	\$0.70
Sandstone curb, 5,790 ft.....	.55	.54	.60	.60
Excavation placed in fill, 1,240 cu. yds.....	.20	.20	.25	.20
Fill in excess of excavation, 4,800 cu. yds....	.53	.50	.45	.50
Foundry sand		.45		
Paving:				
Purinton brick, 10,882 sq. yds.....	1.54	1.48		
Banner brick	1.45	1.43	1.46	1.50
Alton brick			1.46½	1.50
Clinton brick				
Albion brick	1.47	1.40	1.46½	1.50
Wabash brick			1.53	
Danville brick		1.49		
Total	\$21,923	\$21,173	\$22,010	\$22,613

Chicago, Ill.—Concrete, Excavation.—J. T. Fanning & Co., at \$67,950, for excavation and concrete work for substructure of a railway bridge at Mayfair cutoff, for the Sanitary District.

Chicago, Ill.—Bridge Work.—Kelly-Atkinson Co., 188 Madison St., Chicago, at \$9,980, for erection of three superstructures and resurfacing three bridges for the Sanitary District.

Chandlerville, Ill.—Power House.—E. C. Trowbridge for the construction of the new power house for the new municipal electric light plant.

Geneseo, Ill.—Paving.—Keys & McNamara, 1a S. 11th, Ill., at \$10,000, for paving State St.

Taylorville, Ill.—Electric Equipment.—Stewart Construction Co., Cincinnati, O., at \$23,850, for installation of machinery for Taylorville Light, Heat & Power Co.

Attica, Ind.—High School.—J. R. Barnes, Logansport, Ind., for erecting new high school building here.

Burnham, Ind.—Water Works.—Hanrahan & Lindquist Co., Chicago, Ill., at \$9,153, for installing water works for this place, to consist of 1,100 ft. of 12-in. pipe, 1,300 ft. of 10-in. pipe, 3,900 ft. of 8-in. pipe, 2,310 ft. of 6-in. pipe and a compression tank, engine and pump.

Louisville, Ky.—Sewer.—Contract for constructing sewer recently awarded to Herr & Raftus, has been transferred to Schultz & Vogt, Louisville. Contract amounts to about \$7,000.

Pascagoula, Miss.—Sewers, Curbs and Gutters.—Sullivan & Davis Contracting Co., Montgomery, Ala., at about \$20,000, for concrete curbs and gutters and sewers.

Fort Andrews, Mass.—Roads and Walks.—Fred A. Eldredge, Westbury, R. I., at \$19,435, for constructing roads and walks at this post.

Grand Rapids, Mich.—School House.—Charles Hoertz & Son for the construction of the new Coldbrook school on North Ionia St.

Lansing, Mich.—Electric Railway.—A. L. Dorum & Co., 125 Monroe St., Chicago, Ill., for electric railway between Leslie and Jackson for the Michigan United Rys. This is part of the Jackson-Lansing line, the Northern Construction Co. having the contract for that portion between Lansing and Leslie.

Owosso, Mich.—Grading.—Joseph Taylor, Owosso, according to reports, for grading portions of the electric railway from Saginaw to Lansing, via this city.

Crookston, Minn.—Ditch Work.—Valley Dredging Co., Stephen, Minn., at \$9,500, for constructing Ditch No. 73.

Kenyon, Minn.—Sewer System.—Fraser-Elliott Co., Rochester, Minn., for constructing sewer system for this place.

Moorhead, Minn.—Depot.—Johnson, Anderson & Johnson, Fargo, N. Dak., for new freight depot, 30x160 ft., for Northern Pacific Ry. Foundation walls are to be of concrete and superstructure walls of brick.

Helena, Mont.—Water Works.—American Light & Water Co., Kansas City, Mo., according to reports, for the construction for the proposed water works for which \$600,000 was recently voted.

Fargo, N. Dak.—Warehouse.—Johnson, Anderson & Johnson, Fargo, for the construction of a 4-story warehouse for Frank Lynch.

Louisville, Neb.—Bridge.—Contractor Thompson of Omaha for the construction of a wagon bridge across the Platte River at this place. The project has been financed by the Platte River Bridge Co., composed chiefly of Louisville men, and capitalized at \$20,000. It is expected the bridge will cost about \$15,000. It will be a toll bridge, of timber construction on piles. It will be 2,800 ft. long.

Binghamton, N. Y.—Sewer.—J. J. Tyne, at \$1,274, for Lewis St. sewer; John Schulte, at \$1,271, for Mozart St. sewer.

Lancaster, N. Y.—Factory.—Fred Bame for erecting \$20,000 factory for American Malleable Co.

Long Island City, N. Y.—Regulating, Grading, Etc.—Larence Gresser, President Queens Borough, has awarded following contracts for regulating, grading and laying crosswalks: 18th Ave., from Flushing to Wilson, 11, J. Mullen, \$7,277; Academy St., from Washington Ave. to Broadway, National Cement & Construction Co., \$9,450; 14th Ave., from Girard to Vandewater, Astoria Contracting Co., \$3,690; William St., from Paynter Ave. to Beebe, Barth Dunn, \$7,355; Vandewater Ave., from 10th to Old Bowery road, Tossi & Cabaluzzi, \$14,183; 10th Ave., from Winthrop to Riker, Astoria Contracting Co., \$11,446; regulating and grading 17th Ave., from Jackson to Flushing, R. E. Hemings-

ham, \$13,500; paving with asphalt block on a concrete foundation Elm St., from Hopkins Ave. to Ely, Continental Asphalt Co., \$9,146.

Long Island City, N. Y.—Sewer Work.—Contracts for following sewers in Long Island City, Queens Borough, have been let: 17th Ave., from Wilson to Jackson, and Vandewater, from 17th to 18th, Gore Engineering & Contracting Co., \$10,149; 6th Ave., between Flushing and Vandewater, Gore Engineering & Contracting Co., \$2,061; Crescent, from Freeman Ave. to Webster, G. Hill, \$1,130; Webster Ave., from 1st to 3d, G. Hill, \$1,015.

New York, N. Y.—Electrical Work.—Westinghouse Electric & Mfg. Co., New York and Pittsburg, has been awarded contract for electrification of the Pennsylvania terminal in this city. The contract calls for the electrification of the entire Pennsylvania system from Harrison, N. J., to Jamaica, L. I. The initial amount of the apparatus required under this part of the contract will be \$5,000,000.

Syracuse, N. Y.—Sewers.—Charles T. Hookway, at \$3,831, for constructing pipe sewer; Joseph Swift, at \$1,603, for constructing pipe sewer in Avery Ave., Bryant St., and Whittier Ave.

Cincinnati, O.—Viaduct.—Ritter-Conley Mfg. Co., 55 Water St., Pittsburg, Pa., at \$165,244, for the construction of the superstructure of the viaduct for the terminal track from 8th St. and McLean Ave. to 3d and Front St.

Cincinnati, O.—Road Work.—Gephart-O'Malley Co., at \$41,912, for improvement of Duckero-k Road for county.

Cleveland, O.—Sewers.—Christian Burkhardt, at \$24,061, for constructing sewer in E. 4th St.; W. P. Gibbons, at \$16,145, for sewer in Morgana Ave.

Dayton, O.—Pumping Station.—T. J. Backus Construction Co. for the erection of the North Dayton Pumping Station.

Elyria, O.—Meters.—Board Public Service has awarded contracts for water meters as follows: Buffalo Meter Co., 200 $\frac{1}{2}$ -in. at \$6.50; Buffalo Meter Co., 50 $\frac{1}{2}$ -in. at \$9.75; Lambert Meter Co., 400 $\frac{1}{2}$ -in. at \$7.50; Lambert Meter Co., 5 1-in. at \$15.10; Pittsburg Meter Co., 400 $\frac{1}{2}$ -in. at \$6.90.

Guernsey, O.—High School.—R. H. Evans & Co., Zanesville, O., has contract for erecting high school building here.

Springfield, O.—Building Work.—W. W. Luyster, Dayton, O., at \$33,350, for addition to local post office.

Springfield, O.—Sewers, Grading.—Bernard Higgins, at \$5,755, for constructing two sewers; Thomas E. Wren, at \$1,686, for grading and macadamizing West Mulberry St.

St. Clairsville, O.—Bridge, Culverts.—Riverside Bridge Co., for constructing bridge at Blaineville for county; Blaineville Bridge Co., for constructing two concrete culverts.

Enterprise, Ore.—Court House.—S. R. Howarth, La Grange, Ore., for constructing county court house.

Philadelphia, Pa.—Building Work.—The Charles McCall Co., for 2-story and basement school building at the corner of York and Watts Sts. for the Mickve Israel Synagogue. The cost of the building will be \$30,000.

Pittsburg, Pa.—Building.—W. B. Bennett, for constructing East Liberty Y. M. C. A. building to cost \$250,000.

Dell Rapids, S. Dak.—Sewers.—Ward & Dallison, for constructing sewers here.

Houston, Tex.—Brick Work.—Allen & Curry for brick work on the new \$1,000,000 court house.

Salt Lake City, Utah.—Pipe Line.—J. P. O'Neil Construction Co. has been awarded the contract by the Utah Light & Railway Co., for the construction of a half-mile reinforced concrete pipe line and other work, to be done in connection with the new power plant to be erected at Weber Canyon.

Roanoke, Va.—Railroad Work.—D. W. Flickwair for constructing Catawa Valley R. R. from Salem glass factory to the river where sand is obtained. Line is to be 12 miles long.

Monroe, Wis.—Sewer.—O'Farrell Construction Co., Dubuque, Ia., at 63 cts. per foot for constructing 5,600 ft. of 15-in. sewer.

Bellingham, Wash.—Sewer.—Arthur S. Bent, Los Angeles, Cal., at \$24,356, for constructing Champion St. sewer.

Wlota, Wis.—Bridges.—W. H. Shous, Freeport, Ill., for erecting two bridges here.

Cheyenne, Wyo.—Tramway.—Hawes Engineering & Construction Co., Grand Rapids, Mich., for the engineering and construction work for a western smelting company, which requires 14 miles of overhead tramway in Wyoming. Work is to be commenced as soon after Jan. 1 as weather will permit.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States

Phoenix, Ariz.—Work is to be started soon on the construction of a wagon bridge over Salt River at Center St. It will be 2,700 ft. long, 20 ft. wide, and will rest on concrete piers. It will furnish access to lands of Bartlett-Heard Land & Cattle Co.

Augusta, Ga.—Residents of Beech Island District are seeking to have bridge built over Savannah River at Sand Bar Ferry.

Sioux City, Ia.—City Council has been considering plans of City Engineer Skeels for construction of a concrete viaduct at Wall St.

Carlisle, Ky.—Fiscal Court of Nicholas County is to grant franchise for erection and operation of steel toll bridge to be built over the Licking River at Parks Ferry, seven miles north of this city. Company is to be formed to build the bridge.

Winchester, Mass.—Boston & Maine R. R. may be required to build two bridges as a means of abolishing a grade crossing at Winchester Center.

Houghton, Mich.—A \$2,000 appropriation has been made for a new steel bridge over the Menominee River at Twin Falls.

Flint, Mich.—Burton Township has offered this city \$500 toward constructing a bridge over the Flint River near the Flint Axle Works. City is considering constructing bridge to cost about \$10,000.

St. Paul, Minn.—Construction of a steel bridge at Phalen Park to cost \$6,000 is proposed. Fred Nuesbaumer is Superintendent of Parks.

St. Louis, Mo.—Matter of securing engineer for proposed municipal free bridge is again under consideration and bill is before House of Delegates to authorize A. J. O'Reilly, President Board of Local Improvements, to contract with an engineer to take over the entire task of erecting the bridge. The bill fixes the remuneration of the engineer at 4 per cent of the cost of the bridge. The bridge will cost about \$3,500,000.

Lincoln, Neb.—Agreement has been reached by the attorneys of C. B. & Q. Ry., the Missouri Pacific, and the Chicago & Northwestern, for the erection of the 10th St. viaduct. According to the agreement the structure is to be completed by Sept. 15, 1909.

Omaha, Neb.—West Side Improvement Club is advocating the erection of a viaduct at 39th St.

Philadelphia, Pa.—Director of Public Works has held conferences with Pennsylvania and Reading Ry. officials for the erection of bridges over Hunting Park Ave., to the full width of 100 ft.

Portland, Pa.—Delaware, Lacawanna & Western R. R. has been granted permission to build a concrete arch bridge over the Delaware River at Portland.

Reading, Pa.—Council Committee is considering constructing bridge over the Lebanon Valley R. R. tracks at Tulpehocken St. Elmer E. Beard is City Engineer.

Scranton, Pa.—City Engineer is to prepare specifications for a bridge on Balloon St.

Wilkesbarre, Pa.—Grand Jury has recommended that County Commissioner construct 27 new bridges throughout the county. Report recommends construction of 14 stone arch bridges, costing from \$300 to \$600 each, eight concrete bridges, and five iron bridges.

Bellows Falls, Vt.—Town has voted to build a concrete bridge to cost \$12,000 over the canal.

Spokane, Wash.—J. C. Ralston, City Engineer, has completed new plans for the Monroe St. and East Olive Ave. bridges. Plans for the Monroe St. structure provide for a concrete or steel bridge; East Olive Ave. plans provide for concrete structure. East Olive Ave. bridge will cost about \$75,000.

Railroads.

Items Arranged Alphabetically by States

Huntsville, Ala.—Work of constructing the Nashville & Huntsville R. R. is to be resumed at once, according to advices from this city. I. L. McCord is the contractor. T. W. Pratt, Huntsville, is interested.

Phoenix, Ariz.—Harry J. Bennett is promoting the construction of a railway between Phoenix and Mesa City. Surveys are to be started shortly it is said. The road will be operated by gasoline motor cars.

Hope, Ark.—Preliminary surveys are stated to be under way for the route of the Gulf &

Magnolia R. R., which it is proposed to construct from Magnolia to this city, via Waldo. C. N. Black is Chief Engineer.

Paragould, Ark.—Surveys for the proposed extension of the Cache Valley R. R. from Light to Paragould have been completed. The extension will be about 18 miles long. G. W. L. Brown, Sedgwick, Ark., is General Manager.

Alturas, Cal.—Preliminary surveys for the proposed route for the Modoc Northern Ry. are reported well under way. The railroad was incorporated a short time ago by the Southern Pacific Co. to construct a line from Alturas to connect with the California Northeastern Ry. at a point near Klamath Falls, or probably at Midland. B. F. Knowlton, Salt Lake City, Utah, is in charge of the surveys.

Lakeport, Cal.—The Clear Lake Traffic Co. has been incorporated with a capital stock of \$500,000, and proposes to build a line from Lakeport, Lake County, to the tracks of the Northwestern Pacific at or near Pieta, Mendocino County, a distance of about 25 miles. H. F. Stuart of San Francisco is the principal incorporator. James Holland, N. L. Taggart, W. C. Alt-house and Charles Bell, all of San Francisco, are also incorporators.

Quincy, Cal.—Local reports quote J. Rutledge, promoter of the Quincy & Eastern R. R., as stating that construction work was to be started this month. As projected the line is to run from a connection with the Western Pacific at Hartwell Station to Quincy, a distance of about three miles, and on to a point at the Junction of State and Spanish Creeks, a distance of about seven miles.

Denver, Colo.—Utah Copper Co., of which C. M. McNeill, Colorado Springs, Colo., is President, is reported to be considering constructing a railroad to handle the output of its mines. About \$1,000,000 would be expended in constructing the railroad.

Denver, Colo.—Denver & Rio Grande R. R. is reported to be planning to expend about \$12,000,000 for new terminals in Denver, Pueblo, Colorado Springs, Salida and Grand Junction, for new machine shops and improvements, for betterment of the system, for one or two small cutoffs and for standard gaging some of its narrow-gage lines. This work is to be completed by the time the Western Pacific is ready for operation. J. G. Gwyn, Denver, is Chief Engineer.

Chicago, Ill.—Chicago & Proviso Ry. Co. has been incorporated with capital stock of \$5,000, and proposes to construct a railway from Chicago to Proviso. Headquarters are at 135 Adams St., Chicago, and F. D. Kilmer, J. M. Swanson and H. L. Fearing are the incorporators.

Chicago, Ill.—Chicago & Alton R. R. contemplates the expenditure of about \$5,000,000 next year for improvements and betterments. The work is to include, it is said, the completion of the double track from Bloomington to Iles, the extension of the double track from Iles to Girard, and possibly through to Carlinville or even to St. Louis; track elevation in Joliet; track elevation in Chicago; new yards at Brighton Park, and new yards at Summit. W. D. Taylor, Chicago, Ill., is Chief Engineer.

Joliet, Ill.—Chicago & Alton R. R. is said to be planning to at once build the concrete retaining walls preparatory to its track elevation work in this city.

Columbus, Ind.—Extension of local street car service to Hope, 14 miles east of city, is under consideration.

Manhattan, Kan.—Kansas Southern & Gulf R. R. has been sold to W. C. Ross, John A. Fletcher and a Chicago syndicate. The road at present runs from Blaine to Westmoreland, Kan., a distance of nine miles, but the new owners propose to extend the line to Manhattan, and from that place to Wichita. W. C. Ross is President of W. C. Ross Construction Co., and is to have his headquarters in Manhattan.

St. Paul, Minn.—Northern Pacific Ry. has placed an order with the Lackawanna Steel Co. for 12,000 tons of steel rails.

Helena, Mont.—Shields River Valley Ry. Co. has been incorporated with a capital stock of \$10,000, fully subscribed. The company proposes to construct a railroad through the Shields River Valley to a connection with the Northern Pacific at Livingston. William Wallace, Jr., H. K. Jones and T. W. Weir, all of Helena, are the incorporators.

Kearney, Neb.—Kearney & Loup Valley Ry. Co. has been incorporated with a capital stock of \$100,000 and proposes to build a line from Kearney to Hyannis, with a branch to Ravenna. The incorporators are E. H. Morey, W. L. Hand, M. V. B. Sample, W. S. Clapp and Theo. H. Bolte.

Oswego, N. Y.—Rome, Watertown & Ogdensburg R. R. (New York Central Lines)

is reported to be planning to double track its line from Richland to Watertown. Improvements are also planned for the line west of Oswego.

Dickinson, N. D.—Dickinson Commercial Club has had a reconnaissance survey made of the country between Dickinson and the C. & M. Ry., with a view of putting in an independent line. The distance is about 25 miles.

Conneaut, O.—Work is to be started here, according to reports, on the construction of the Lake Erie & Youngstown R. R., of which John H. Ruhlman, Youngstown, is the promoter. George Tod, Jr., Youngstown, is Chief Engineer.

Pittsburg, Pa.—F. H. Skelding and H. W. McMaster, Receivers of the Wabash-Pittsburg Terminal Ry., have been granted authority to issue receivers' certificates in the amount of \$874,211. Out of this 14 tunnels are to be relined at a cost of \$687,073 and 77 steel bridges are to be repainted at a cost of \$63,136. Two locomotives, a steam derrick and other equipment and tools will be purchased for the line. H. T. Douglas, Jr., Pittsburg, Pa., is Chief Engineer. The receivers have also requested leave to expend \$720,000 on the West Side Belt R. R.

Aberdeen, S. Dak.—Dakota Southern Ry. Co., mentioned in our last issue, is reported to be having surveys made from Rapid City to Williston, N. Dak. The incorporators of the company are: Chas. F. Merry, John Reisbeck, Dickinson, N. Dak.; John C. Johns, Hettinger, N. Dak.; George L. Lemmon, Ed. C. Delehan, Lemmon, S. Dak.; L. E. Gaffy, Bernie Morse, Pierre, S. Dak.

El Paso, Tex.—San Diego, El Paso & St. Louis Ry. Co., with capital stock of \$100,000, has applied for charter and proposes to build a railway entirely within the County of El Paso, from a point within the city of El Paso to the boundary line of Texas and New Mexico, the line to run in a northeasterly direction from El Paso, and not to exceed 100 miles. The principal office of the railroad will be maintained at El Paso. The incorporators are A. Courchesne, James A. Dick, John A. Happer, W. C. Davis, Horace B. Stevens, Z. T. White, L. E. Booker, J. B. Mundy, W. J. Harris, W. Cooley, Irvin John, J. A. Smith, all residents of El Paso.

Graham, Tex.—The construction of a railway 265 miles long is proposed by the Graham, Roswell & Western Ry. Co., which has applied for a charter. As proposed the road is to extend from the town of Graham in a westerly direction, through the counties of Young, Throckmorton, Haskell, Stonewall, Kent, Garza, Lynn, Terry and Yoakum, to a point on the western boundary line of Yoakum County, near its northwestern corner. The incorporators are: S. R. Crawford, John E. Morrison, D. G. Vick, E. S. Graham, A. D. Goodenough, R. F. Arnold, S. B. Street, R. E. Mabry, H. P. Faris, J. W. Gallaher, H. L. Morrison, M. K. Graham and C. W. Johnson.

Marshall, Tex.—Application has been made for a charter for a railroad to be constructed between Marshall and Beaumont, a distance of 200 miles. L. E. Walker and Joseph Lake, of Marshall, are interested.

Galveston, Tex.—County Commissioners and railroads have reached an agreement for the construction of a causeway to connect Galveston Island with the Mainland. The causeway will cost \$1,400,000.

Norfolk, Va.—Alvah H. Martin and others have applied for a charter for the Lynn Haven Terminal Co., of Norfolk. The company proposes to build a railroad from Norfolk to Cape Henry, to operate a ferry line to Cape Charles and to build its line of road from that point to some point on the Rappahannock River.

Norfolk, Va.—Receivers for Norfolk & Southern Ry. have recommended that certificates for \$1,000,000 be issued for the completion of the 8-mile bridge over Albemarle Sound, construction of a terminal station at Norfolk, and other improvements. F. L. Nicholson, Norfolk, Va., is Engineer M. of W.

Richmond, Va.—Richmond, Urbana & Peninsula Ry. Co. has been granted charter. The company proposes to connect West Point and Urbana traversing the valleys of the Rappahannock, York and Mattaponi Rivers. The officers are: John C. Robertson, of Chesterfield, President; Boyce D. Brooker, of Richmond, Vice President; Geo. C. Bland, of King and Queen County, Treasurer, and James Taylor Robertson, of Chesterfield, Secretary.

Roanoke, Va.—Surveys are reported under way for a railroad for Roanoke to Floyd Court House, a distance of 25 miles. H. H. Rogers, owner of the Virginian Ry., is reported as interested in the project, and the surveys are being made by engineers of the Virginian Ry., it is said.

Electric Railways.

Items Arranged Alphabetically by States.

Birmingham, Ala.—Birmingham & Shades Mountain Electric Ry. Co., which proposes to construct an electric railway into Shades Valley, has opened offices in the Brown-Marx Bldg.

Huntsville, Ala.—Local electric railway company has been having surveys made for several extensions. One of these is to the top of Monte Sano.

Fayetteville, Ark.—Louis Moulton of Boston, Mass., has applied for franchise for an electric street railway to connect with an electric line from Siloam Springs to Huntsville. S. T. Propper, Minneapolis, Minn., is securing right of way for a belt line to be connected with a road to Joplin Mo.

Fresno, Cal.—Work is to be started here by Dec. 15, according to reports, on the construction of the Hanford-Fresno traction line. The promoter of the line, F. S. Granger, is to at once open main offices in Fresno.

Sacramento, Cal.—Advice from this city state that W. A. Smith, Minneapolis, Minn., is contemplating the construction of a railway from this city to Lake Tahoe, tapping a lumber tract which he owns in El Dorado County. He is said to be negotiating for the purchase of the old Pioneer Mills on the water front at this city for a landing place on the river.

Wilmington, Del.—Local press reports state that a company to be known as the Delaware Central Ry. Co. is being formed by New York capitalists for the purpose of constructing an interurban line from this city to Delmar.

Waterloo, Ia.—A large portion of the right of way is stated to have been secured by the Iowa Ry. Co. for its proposed line from Waterloo, with a branch from Cedar Falls, in a southwesterly direction through Graundy Center, Eldora, Garden City, Roland and Ames. From there it is planned to take a direction southeast to Shipley on the line of the St. Paul & Des Moines, and from that point use the tracks of that road at least as far south as Elkhart. From Elkhart it is proposed to come in over the tracks of the Des Moines & Western. The road is being promoted by George W. Ball and Wilbur Marsh, of Waterloo, George W. Scott, Security Bldg., Chicago, Ill., is said to be the consulting engineer.

Springfield, Ill.—Springfield & Jacksonville Electric Ry. Co., recently incorporated with a capital stock of \$100,000, and headquarters in this city, will, it is said, have construction work started this fall. The line is to run from this city through Sangamon and Morgan Counties to Jacksonville. Among those interested are D. H. Sims, Latham, Ill., and C. R. Cronk, 550 Irving Park Boulevard, Chicago, Ill.

East St. Louis, Ill.—The East St. Louis, Caseyville & Eastern Ry. Co. has been incorporated by F. G. Harding, Joseph Harding and E. G. Helm, and proposes to build an electric line from East Lansdowne to Caseyville.

Winona Lake, Ind.—Winona Interurban Ry. Co., has raised \$300,000 with which to complete the extension of its line from Warsaw to Peru. The company now operates a line from Warsaw to Goshen, and has plans prepared for a line between Warsaw and Ft. Wayne and from Warsaw to Valparaiso connecting Warsaw with Chicago by another and second route. It is hoped to begin work on that line next summer.

Meridian, Miss.—Meridian Light & Railway Co. is being petitioned to extend its line to the mountains south of the city.

Syracuse, N. Y.—Residents of Pompey have offered Syracuse & Suburban Ry. Co. a bonus of \$50,000 and right of way if the company will build an extension to that place. About 17 miles of track work would be required.

Oneida, N. Y.—Oneida Ry. Co. has applied for franchise allowing it to build from Kenwood to Sherrill.

Carlisle, Pa.—Surveys are being made for the proposed Carlisle to Newville electric railway.

York, Pa.—Ordinance is before City Council to permit the York Rys. Co. to double track its line on portions of several streets.

San Antonio, Tex.—A large plot of land near here has been purchased of Col. Dave Light. It will be laid out as a palm garden and connected with this city by an electric railway.

Sisterville, W. Va.—Union Traction Co., which operates between Sisterville and New Martinsville, will be extended from New Martinsville to Hannibal next year, accord-

ing to the announcement of W. H. McCoy, its President.

Everett, Wash.—Stone & Webster Co., Boston, Mass., which recently purchased the Everett-Seattle Interurban line, will at once rush the line to completion, according to advices from this city. W. L. Sturtevant is local manager for Stone & Webster.

Beaver Dam, Wis.—Construction of the Milwaukee & Western Electric Railway from Beaver Dam to Oconomowoc is to be begun at once, according to W. A. Dunn of Milwaukee, President of the company.

Sewers.

Items Arranged Alphabetically by States.

Birmingham, Ala.—Work is to be started at once on the construction of the new system of storm and sanitary sewers for this city, to cost about \$550,000.

Madera, Cal.—Village Trustees are considering purchasing system of Madera Sewerage Co. or installing new system.

East Point, Ga.—City has voted to issue \$50,000 of bonds, \$20,000 of which is for sewerage.

Athens, Ga.—City Engineer Barnett is making estimates for the construction of several sewers.

Oskaloosa, Ia.—Riverside residents have petitioned City Council to construct a storm sewer in that section.

Lincoln, Ill.—Board Local Improvements is to construct a 4,180-ft. long sewer in North Hamilton St.

Olney, Ill.—Special election is to be held to vote on constructing sewer system.

Sterling, Ill.—City will have to extend brick outlet of Ave. B sewer system about 200 ft. into the river.

Prophetstown, Ill.—Sewer, to cost \$7,000, is to be constructed in Locust St.

Indianapolis, Ind.—Following bids per lin. ft. were received Oct. 30 by Board Public Works for constructing Elightwood sewer system: John Jenkins, \$9.03; Mansfield Engineering Co., \$10.29; Sheehan Construction Co., \$10.72; American Construction Co., \$11.42; and William Yates & Co., \$11.48. Estimated cost of sewer is about \$190,000.

Vincennes, Ind.—City Council has passed ordinance appropriating \$2,500 for the Board of Works, to be used by that body in employing a civil engineer to work upon plans and specifications for a general system of storm and sanitary sewerage for the city.

Bowling Green, Ky.—City voted Nov. 3 on issuing \$15,000 of bonds for building outlet for sanitary sewer system. W. H. Philips is City Clerk.

Glasgow, Ky.—City will issue \$15,000 of bonds for sewer system and other improvements.

Lexington, Ky.—Construction of sanitary sewer in South Broadway is proposed.

Big Rapids, Mich.—County Supervisors are to construct 1,000 ft. of 8-in. pipe sewer for county poor farm.

Grand Rapids, Mich.—Board Public Works will at once call for bids for four sets of pumps for the sewage pumping stations. L. W. Anderson is City Engineer.

Owosso, Mich.—Construction of sewer in Williams St. is proposed.

Albert Lea, Minn.—Bids are to be asked for constructing brick or concrete trunk sewer.

St. Paul, Minn.—Aldermanic Committee on Streets has reported in favor of authorizing a \$75,000 bond issue for construction of the Portland-Aldine main sewer system.

Covington, Ky.—Ordinances have been passed for new sewers in Julia St. and 15th St.

Albuquerque, N. Mex.—Report of Samuel Gray, Consulting Engineer Providence, R. I., on a new sewer system for this city has been submitted to the City Council.

Batavia, N. Y.—Plans and specifications for a sewer system for this village have been made. Myron H. Peck is chairman of Sewerage Advisory Committee.

New York, N. Y.—In making up the tentative budget for next year the Board of Estimate has made the following sewer allowances for the various boroughs: Manhattan, \$355,000; Bronx, \$222,000; Brooklyn, \$521,000; Queens, \$167,000; Richmond, \$59,000.

Niagara Falls, N. Y.—George W. Knox, President of the local Board of Trade has appointed a committee consisting of Mayor A. C. A. Douglass, Alexander J. Porter and E. T. Williams to confer with like committees from the civic bodies of the Tonawandas, Buffalo, Lockport and other interested communities, relative to the formulation of a plan to present to the government to pre-

vent the emptying of sewage in the Great Lakes and tributary waters.

Alliance, O.—State Board of Health will probably direct this city to construct a sewage disposal plant. City Engineer has been directed to prepare plans and specifications for such a plant.

Hamilton, O.—City Engineer has plans under way for several storm sewers for south end of city.

Oklahoma City, Okla.—City Engineer Burke has prepared estimates for extension of Blackwelder Ave. main sewer.

Harrisburg, Pa.—Council has passed ordinance for sewers for the Kunkel Addition.

Polk, Pa.—State Health Department, Harrisburg, Pa., has completed plans for sewage disposal plant for the State Institution for Feeble-Minded at Polk, and Trustees of that Institution will award contract for the work.

Sharon, Pa.—State Health Department has directed the Boroughs of Sharon, South Sharon and Sharpsville to build a sewage disposal plant. The boroughs have until Dec. 1, 1909, to arrange plans.

Scranton, Pa.—Plans for new sewer of Sec. C of the 18th sewer district have been completed. Estimated cost is \$9,000.

Bennettsville, S. C.—Bandy & Myers, Engineers, are preparing plans for sewer system for this place.

North Yakima, Wash.—City Council proposes to extend trunk line sewer for 2,500 ft. at a cost of about \$5,000.

Spokane, Wash.—Lang & Smith, at \$21,390, were low bidders, Oct. 29, for constructing sub-trunk sewer in the First Ward.

Kenosha, Wis.—Residents of Ashland Ave. have started injunction proceedings to prevent the use of Jerome Creek as an open sewer. The movement is taken to force the building of a trunk sewer through the southern part of the city, costing about \$200,000.

Water Supply.

Items Arranged Alphabetically by States.

Corning, Cal.—City Trustees are considering constructing water and sewer systems.

San Francisco, Cal.—Mojave Water & Power Company, with capital stock of \$20,000,000, and San Francisco as its place of business, has been incorporated. The incorporators are: Julien Mathieu, Harry C. Mack, C. F. Metter, all of Oakland; F. C. Van Deinsse and C. S. Goodrich, of San Francisco.

Yuba City, Cal.—City Trustees are perfecting plans for a new municipal water system.

Lamoni, Ia.—City Council is making arrangements for installing waterworks.

Waverly, Ia.—Plans are being drawn by J. C. Ralston for new waterworks to be installed here.

Winterset, Ia.—A \$60,000 bond issue for constructing water works has been voted. W. K. Palmer Co., Engineers, Dwight Bldg., Kansas City, Mo.

Colfax, Ill.—Village Board is considering installing a new water works system.

Albany, Ky.—City is considering installing water works.

Shepherd, Mich.—City has voted to issue bonds for installing water works.

Crookston, Minn.—City Council has voted to extend the water mains.

Wiggins, Miss.—City Council is considering installing municipal water works.

Bosworth, Mo.—New water works will be installed here.

Weldon, N. C.—City is prepared to grant exclusive franchise to private corporations for water works. D. E. Steinback, Clerk of City Board.

Newark, N. J.—Borough of North Arlington may hold special election to vote on issuing \$25,000 of bonds for installing water works.

Shawnee, O.—Following bids were received Nov. 5 by this village, Bradbury & Shute, Engineers, Columbus, O., for furnishing and laying cast iron water pipe, etc., (1) standing for Richards Plumbing Co., Columbus, O., (2) for U. S. Construction Co., Columbus, O., and (3) for Pitt Construction Co., Pittsburg, Pa.:

Items.	(1)	(2)	(3)
Excavation, 9,433 ft. ...	0.27½	\$ 0.18	\$ 0.25
4-in. pipe, 2,682 ft.	.41	.38	.58
6-in. pipe, 1,450 ft.	.61½	.54	.68
8-in. pipe, 2,300 ft.	.81½	.75	.87
Specials, 2.8 tons.	118.00	75.00	100.00
4-in. valves, 27.	15.05	12.50	12.00
6-in. valves, 9.	20.80	17.50	16.00
8-in. valves, 7.	29.20	22.00	20.00
Hydrants, 22.	30.75	27.00	35.00
Concrete, 10 cu. yds. ...	12.50	6.00	10.00
Total.	\$10,315	\$8,358	\$10,699

Burton, O.—Village has purchased site for its proposed water works plant.

Findlay, O.—Board Public Service is to install pumps to cost \$5,500 at Limestone Ridge.

Cherokee, Okla.—Election is to be held to vote on issuing \$25,000 water works and \$40,000 sewer construction bonds. A former bond issue was declared illegal, necessitating a new election.

Erick, Okla.—City has issued \$20,000 of bonds for a water system.

Avondale, Pa.—The Weavertown Water Co., of North Lebanon, East Lebanon and vicinity, has sold its water plant at Avondale and its distributing system to a syndicate composed of Conrad Hambleton, of Carlisle, Pa.; E. E. Brunner, of York Haven, Pa., and W. A. Thomas, of Millintown.

Anson, Tex.—Surveys are being made for water works for this town.

Renton, Wash.—Election was held Oct. 31, to vote on bonding for \$23,000 for construction of water supply system.

Spokane, Wash.—The Deer Lodge Land & Water Co. has been incorporated with a capital stock of \$200,000. The incorporators include Thos. H. Brewer, John H. Tilsley, Hugh H. McMillan.

Port Orchard, Wash.—Water works and electric light plant are planned for this place by William Radey.

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FORT MYER, VA., OCTOBER 20, 1908. Sealed proposals in triplicate will be received at the office of the Constructing Quartermaster, until 11 a. m., November 18, 1908, and then opened, for the construction of fences for corrals for artillery stables at Fort Myer, Va. Certified check or Surety Company's guarantee for 10 per cent of the amount must accompany each bid. Plans and specifications will be furnished upon application. The Government reserves the right to reject any or all bids. Proposals and envelopes should be marked "Proposals for construction of corral fences," and addressed to Captain E. B. HYER, Constructing Quartermaster.

U. S. ENGINEER OFFICE, WILMINGTON, N. C., October 20, 1908. Sealed proposals for constructing a steel draw-span highway bridge with pile and concrete foundations, on Core Creek, near Beaufort, N. C., will be received at this office until 12 noon, standard time, November 20, 1908, and then publicly opened. Information furnished on application. EARL I. BROWN, Captain Engineers.

WATER-WORKS.

Lamar, Colorado.

Sealed bids for the furnishing of all materials, supplies, labor, etc., and the sustaining of all of the expense incurred in construction in place Section Number One of the Lamar Water Works together with all appurtenances, for the Town of Lamar, in the County of Prowers, State of Colorado, as ordered and authorized by resolution of the Board of Trustees of the said Town of Lamar, and in accordance with the details, plans and specifications adopted and prescribed by the board of Trustees of said Town, will be received at the office of the Town Clerk and Recorder of said Town of Lamar, in said Town of Lamar, until 8 o'clock, p. m. on Monday, the 16th day of November, A. D. 1908, at which hour all bids will be publicly opened and read aloud at the Town Hall of said Town. Upon opening the bids the Mayor will canvass the same and if any is accepted will, without unnecessary delay, award the contract subject to the approval of the Board of Trustees of said Town; but the right is reserved to the Board of Trustees of said Town to reject any and all bids.

The successful bidder shall be required to furnish a bond in the sum of 30 per cent of the amount of his bid with surety to be approved by the Mayor of the Town of Lamar, for the faithful performance of the contract.

To insure good faith on the part of the bidder, a cashier's check in the sum of one thousand dollars (\$1,000.00) on some bank in Lamar, Colorado, must accompany each bid, which check shall be payable to the Treasurer of the said Town of Lamar to be forfeited to the said Town as liquidated damages in case the bid shall be accepted and the bidder shall fail, for ten days after notice of the approval of the acceptance thereof by the Board of Trustees of the Town of Lamar, given personally or by mail to the address of such bidder to enter into the contract awarded him.

Section Number One of the Lamar Water Works hereinabove referred to is located twelve miles south of three-quarters of a mile east of the Town of Lamar, Colorado, on Clay Creek, the exact location being more particularly described as being in the east half (E. ½) of Section thirty-two (32), Township twenty-four (24), south, range forty-six (46), west of the sixth principal meridian. The work consists of the construction of a dry rubble subterranean collecting gallery of small cross section and the construction of approximately 3,200 linear feet of 12-inch pipe line, together with other appurtenances, as will more fully appear and be shown by the plans and specifications for said Section Number One of the Lamar Water Works on file in the office of the clerk and recorder of the Town of Lamar, Colorado, which details, plans and specifications may be seen and examined at the office of the said Town Clerk and Recorder on and after the date hereof.

CHARLES MAXWELL,
Mayor.

U. S. ENGINEER OFFICE, CHICAGO, Ill., Nov. 2, 1908. Sealed proposals for pile pier construction and removal of old pier in Michigan City Harbor, Ind., will be received at this office until 10 a. m. Dec. 12, 1908, and then publicly opened. Information on application. THOS. H. REES, Mayor, Engineers.

FILTRATION PLANT.

Wilmington, Del.

Sealed proposals will be received by the Board of Water Commissioners at the office of the Water Department, southeast corner Sixth and King Streets, Wilmington, Delaware, until 10:30 a. m. on Monday, Nov. 23, 1908, for the construction of a covered, slow sand filtration plant, together with filtered water reservoir, filter sand washing apparatus and other appurtenances; the kind and the amount of work to be done or furnished under said proposals to be according to plans and specifications which may be seen in detail at the office of the Chief Engineer of the Water Department, southeast corner Sixth and King Streets, Wilmington, Delaware, to which reference is hereby made.

The contract for the doing of the work and the furnishing of all materials and supplies covered by such plans and specifications will be awarded to the lowest and best bidder, provided that the Board of Water Commissioners reserves the right to reject any or all bids.

Each bid must be signed by the bidder and be accompanied by an undertaking signed by the persons offered by the bidder as his sureties, who must, in all cases, be resident freeholders of the City of Wilmington, or a thorough responsible surety company, which company or companies must be acceptable to the Board of Water Commissioners, declaring their consent to be such sureties in the event of the contract being awarded to such bidder; and if any contract be so awarded, and such bidder shall fail to complete the execution of a contract therefor, with security for its performance approved by the said Board, such bidder and the party or parties, company or companies, so undertaking for him, as aforesaid, shall be liable to pay to the City of Wilmington any damage that may be occasioned to said city by such failure; bond required in the sum of 25% of the contract price.

Form of proposals and contracts may be obtained at the said office of the Chief Engineer of the Water Department.

Copies of the specifications and plans may be secured upon making a deposit of twenty-five dollars, said deposit to be returned upon the return of the plans and specifications.

By order of Board of Water Commissioners.

JOHN A. KIENLE, Chief Engineer.
Attest: CHAS. MCINTIRE, Secretary.

CHILEAN RAILWAYS.

The Government invites proposals for the construction of the following new sections of railway:

From the port of Arica, on the coast of Chile, to alto de La Paz, the capital of Bolivia, an extension of about 460 kilometers.

From La Ligua to Copiapo, an extension of approximately 680 kilometers—all within the Republic of Chile.

Proposals should be addressed to the Minister of Public Works, Santiago, Chile, or to the Legation of Chile, Washington, D. C.

The Legation at Washington will furnish all particulars to contractors desiring to bid upon the work. The date for opening the bids by the Minister of Public Works in Santiago, Chile, is Feb. 1, 1909, for the La Ligua-Coplapo Railway.

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Notice to Contractors

We have the following work to sub-let:

At Joliet, Ill., on the E. J. & E. R. R., about 2,000 cu. yds. concrete in retaining walls.

At same place, about 30,000 cu. yds. earth to move average of 200 ft.; extreme haul less than 500. This is in a cut, 1,700 ft. long, 10 ft. deep and 36 ft. wide at bottom. Material is wasted.

Also have at Evanston, Ill. (Chicago suburb), 50,000 cu. yds. top loam to be wasted over a 25-ft. berme.

Also have about 100,000 cu. yds. good work for a drag line excavator with 70 or 80 ft. boom.

INTER-STATE CONTRACTING CO.,
509 Monadnock Block, Chicago, Ill.

TILE DRAINS.

Peoria, Illinois.

Sealed bids will be received by the Commissioners of the Hallock & Medina Drainage District of Peoria County, Illinois, at the office of W. S. Kellogg, Attorney, 100 S. Jefferson Ave., Peoria, Illinois, until two o'clock p. m. the 14th day of December, A. D. 1908, for furnishing and laying 31,757 feet of drain tile ranging in size from 8-inch to 30-inch diameter.

Bids must be accompanied by cash or certified check equal to 10 per cent of the amount of the bid. Contractor will be required to file bond in the amount of 50 per cent of the estimated cost of the work. Plans and specifications can be seen at the office of the Harman Engineering Co., 120 Fredonia Ave., Peoria, Illinois. Copy of specifications and form of bid may be procured by application to the Engineer. Payments will be made in cash on monthly estimates. Works to be completed on or before the first day of November, A. D. 1909.

Commissioners reserve the right to reject any and all bids.

ZEALY M. HOLMES,
ALONZO M. ROOT,
IRVING J. CASE,

Commissioners.

HARMAN ENGINEERING CO., Engineers,
120 Fredonia Ave., Peoria, Ill.

NOTICE TO DREDGING AND TILE DRAIN CONTRACTORS.

Burlington, Iowa, Oct. 20, 1908:

Sealed bids will be received by the Joint Board of Supervisors of Louisa County and Des Moines County, State of Iowa, acting for and on behalf of the Louisa-Des Moines Drainage District Number 4 of said counties, at the office of the Auditor of Des Moines County, Burlington, Iowa, until two o'clock p. m., November 14, A. D. 1908, at which time and place said bids will be publicly opened. The work for which bids are asked is a part of the drainage system of said Drainage District as follows, viz.:

Section 1. Excavation, 200,000 cu. yds.
Section 2. Excavation, 17,460 cu. yds.
Section 3. 18-in. tile drain, 8,200 lin. ft.
15-in. tile drain, 2,400 lin. ft.
as described in detail in the specifications therefor on file with the Auditor of each of said counties.

Each bid must be accompanied by cash or certified check equal to ten per cent of the amount of the bid.

Plans and specifications are on file and may be seen at the office of the County Auditor of Louisa County, Wapello, Iowa, at the office of the County Auditor of Des Moines County, Burlington, Iowa, and at the office of the Harman Engineering Co., Engineers, 120 Fredonia Ave., Peoria, Illinois. Copy of specifications, Form of Contract and Form of Bid may be procured by application to the Engineers.

Joint Board,

D. H. V. HERRICK,

O. C. FARMER,

R. S. JOHNSTON,

Supervisors of Louisa County.

A. SCHWALLER,

R. D. SIEFKEN,

JOHN H. PETTIBONE,

Supervisors of Des Moines County.

DAN P. HULL, County Auditor, Des Moines County.

H. W. BAKER, County Auditor, Louisa County.

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Engineers,

120 Fredonia Ave., Peoria, Ill.

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One 26 ft. wide by 75 ft. long, Hoisting Engines 12 inches by 18 inches, made by the Toledo Foundry & Machine Co.

One 21 ft. wide by 59 ft. long, Hoisting Engines 9 inches by 13 inches, made by The Bucyrus Company.

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ASSIGNEE'S SALE**MONDAY, NOVEMBER 23**

On the Grounds at California, O., Cincinnati, O., New Water Works, all the Equipments of the Keeling & Ridge Co., Located at California, O., will be Sold at Public Auction, in Separate Lots.

THIS contractor's outfit represents an outlay of about two hundred thousand dollars (\$200,000). The sale will positively take place on Monday, Nov. 23, at 9:30, and continue until everything is sold, regardless of the weather. There is such a vast stock, that there will be many wonderful bargains. The sale will be conducted in a strictly business-like manner, everything warranted to be exactly as represented and fair trial given to purchasers of the horses and mules, which we estimate the aggregate value at twenty thousand dollars (\$20,000). There are hundreds of wagons and harness of all kinds, plows, scrapers, steam shovels, Jackson conveyors, large and small locomotive cranes, several hoisting engines, 3 13-ton Kelly Springfield road rollers, concrete mixers, road machines, 100,000 feet of lumber, and a complete outfit of contractor's supplies.

CATALOGUE and All Particulars will be Furnished by Applying to the

MERCANTILE TRUST COMPANY, OF PITTSBURG

Assignee of the Keeling & Ridge Co.

J. S. JACKSON, Agent, California, O.. Cincinnati Water Works

J. O. WOODWARD, Auctioneer, 43 Wiggins Blk., Cincinnati, O.

PIER CONSTRUCTION.

San Francisco, Cal.

Sealed proposals or bids will be received at or prior to 9:15 o'clock, a. m., on November 19, 1908, for furnishing the labor and materials (except cement, creosoted mooring piles and track rails with fish plates), for the construction of a pier and shed over same, to be known as Pier No. 38, on the water front of the City and County of San Francisco, State of California, at foot of First and Townsend streets, according to the plans and specifications prepared therefor by the Asst. State Engineer, and adopted by the Board on October 15, 1908, and on file in this office, to which special reference is hereby made.

The materials to be used in this work will consist of the requisite quantities of fresh cut, close grained Douglas yellow fir piles, creosoted piles, merchantable yellow fir lumbers, staves for cylinders, band iron, Portland cement, sand, crushed rock, reinforcing material, castings, steel-beams, steel plates and angles, bolts, rivets and spikes, car springs, steel rails and fastenings, asphalt, paving brick, glass window frames, rolling steel shutters, etc.

Bidders are invited to be present at the opening of the bids.

W. V. STAFFORD,

W. E. DENNISON,

HENRY J. CROCKER,

Board of State Harbor Commissioners.

RALPH BARKER, Asst State Engr.

W. B. THORPE, Secretary.

PUMPING ENGINE.

Meridian, Miss.

Sealed proposals will be received at six o'clock p. m., Tuesday, November 24th, for furnishing and erecting one five million gallons Horizontal Cross Compound Crank and Fly Wheel Pumping Engine, in accordance with the plans and specifications now on file in the office of the Secretary of the Water Commission, and approved this, the 26th day of October, 1908.

Specifications and blank forms of proposal may be obtained at the office of the Board.

A certified check on the Meridian Bank in the sum of \$1,000 is to be deposited with J. A. Gibson, Treas., before filing bid.

A surety company bond for amount equal to 25 per cent of the gross amount will be required of the successful bidder.

The right is reserved to reject any and all bids.

C. C. DUNN, Pres. Comn.
W. F. WILCOX, Engineer.**PUMPING ENGINES.**

Augusta, Georgia.

Sealed proposals will be received by the Water Work Committee of the City Council of Augusta, Ga., until 4 p. m. (Eastern time) Tuesday, November 24th, 1908, for furnishing and erecting at Augusta, Ga., a pumping engine of six (6) million gallons daily capacity and a steam plant of four hundred and fifty (450) horsepower capacity.

The city reserves the right to reject any or all proposals.

Specifications can be had by applying to this office.

NISBET WINGFIELD,
City Engineer.**WATER-WORKS.**

Wenatchee, Wash.

Sealed proposals will be received by the City Clerk at his office in the City of Wenatchee, Washington, up to 12 o'clock m., November 24th, 1908, for the construction and completion of pumping station on the banks of the Columbia River at the foot of Fifth street north and construction of a pipe tunnel from pumping station to junction with the existing tunnel.

Furnishing pump, motor and starting panel.

Pipe line to reservoir.

Reservoir complete, including coping and iron fence.

Overflow pipe from reservoir.

Bids may be for the entire work as set forth in the plans and specifications, or for any of the several divisions of the work set forth in the plans and specifications.

All bidders receiving a copy of the plans and specifications must deposit \$15 for the return of same.

ROY ZAHREN, City Engineer.

SAM R. SUMNER, City Clerk.

RAILROAD LOCATION**A College Text Book**

NO course in civil engineering is complete without a thorough course in railroad location, for the methods used in railroad surveys are applicable to highway surveys, canal surveys, etc. A book that is admirably adapted for use as a text-book, or as a supplement to lectures, is Railroad Location Surveys and Estimates, by F. LAVIS, M. Am. Soc. C. E. It has been adopted by several engineering colleges, and is generally conceded to be the clearest exposition of modern field methods yet published. It is written by an engineer of wide experience in railroad work.

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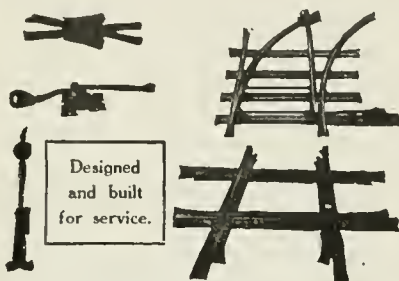
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SEWERS.

Wellington, Kansas.

Sealed proposals will be received by the City Clerk of Wellington, Kansas, up to 8 o'clock p. m. of November 16, 1908, for furnishing material and constructing the sewers in District No. 3, according to plans and specifications prepared by H. A. Rowland, C. E. of McPherson, Kansas, and adopted by the Mayor and Council of the City of Wellington, Kansas, and also for furnishing material and constructing the main intercepting sewer from the corner of 10th and 11 streets to the outlet on Slate creek, according to plans and specifications prepared by H. A. Rowland, C. E., and adopted by the Mayor and Council of the City of Wellington, Kansas.

The city reserves the right to reject any and all bids.

Each bid must be accompanied by a certified check for \$500.00, payable to the City of Wellington.

A. B. CHEEVER,
City Clerk.

CONCRETE RESERVOIR.

Meridian, Miss.

Sealed proposal will be received at six o'clock, p. m., Tuesday, November 24th, for furnishing all tools and material in the construction of reinforced concrete reservoir, in accordance with plans and specifications now on file in the office of the Secretary of the Water Commission, and approved this, the 19th day of October, 1908.

Specifications and blank form of proposal may be obtained at the office of the Board.

A certified check on the Meridian Bank in the sum of \$500 is to be deposited with J. A. Gibson, Treas., before filing bid.

A surety company bond for amount equal to 25 per cent of the gross amount will be required of the successful bidder.

The right is reserved to reject any and all bids.

C. C. DUNN, Pres. Comn.
W. F. WILCOX, Engineer.

BOILERS, STEAM ENGINES AND CENTRIFUGAL PUMPS.

Pekin, Ill., Oct. 26, 1908.

Sealed bids will be received by the Commissioners of the Spring Lake Drainage and Levee District, at the office of W. A. Potts, Attorney, Pekin, Illinois, until ten o'clock a. m., Tuesday, November 24th, A. D. 1908, for two 250 H.P. water tube boilers, two 350 I.H.P. compound condensing steam engines direct connected to two 45-inch or 48-inch centrifugal pumps with 48-inch discharge pipes, and one 100 H.P. compound condensing steam engine, direct connected to one 24-inch centrifugal pump with 26-inch discharge pipe, together with all appurtenances and fixtures complete on foundation to be furnished by the purchasers in their pumping plant at the lower end of the Spring Lake Drainage and Levee District on the east bank of the Illinois river about seventeen miles south of Pekin, Illinois.

Bids must be accompanied by certified check of five (5) per cent of the amount of the bid.

Plans and specifications and full information will be furnished upon application to the Engineers.

HARMAN ENGINEERING CO.,
Engineers.

120 Fredonia Ave., Peoria, Ill.

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- Two No. 2 1-2 Smith's on Truck, with Engine and Boiler.
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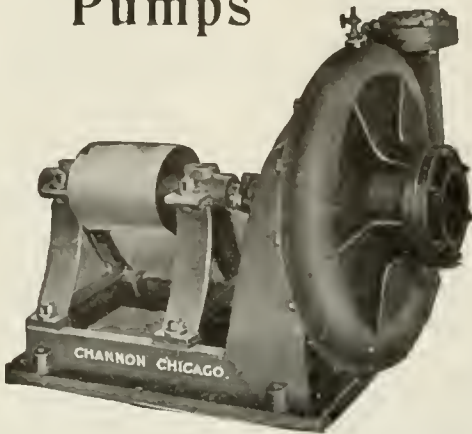
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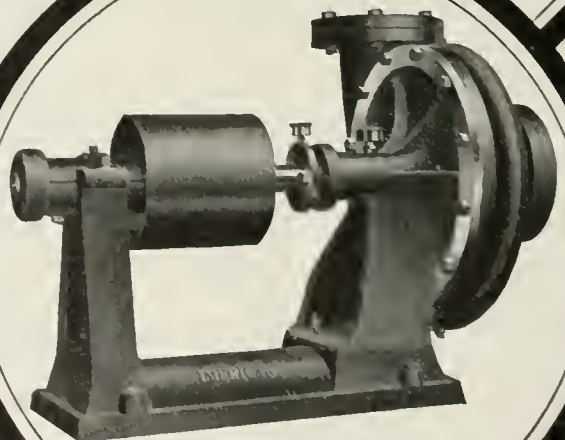
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Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

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The Competitive System of Contracting vs. the Fixed Fee System.

During the past twelve years a system of contracting has been developed that bids fair to make the old competitive system look to its laurels. Known under various names, such as "cost plus a fixed sum," "the fixed commission system," etc., this fixed fee system has been employed on many engineering and architectural works of all sizes. The steady increase in popularity on certain classes of construction work proves conclusively that it has merit as a system for executing both public and private work.

It is our purpose briefly to indicate the merits and the limitations of the fixed fee system, and to point out the lines along which it will probably develop its greatest influences.

The proponent of the fixed fee system of contracting was the "percentage system," under which a contractor agreed to perform work at actual cost plus a specified percentage, ordinarily 10 to 15 per cent. The percentage system possesses the following advantages:

(1) It relieves the contractor of the burden of uncertainty as to materials and conditions to be encountered, and places that burden upon the government, the railway company, or the owner.

(2) It enables the contractor to begin work before surveys or plans are completed.

(3) It eliminates bills of extras.

(4) It reduces very greatly the number of lawsuits arising over interpretation of the specifications or contract.

On the other hand, the percentage system possesses the following disadvantages:

(1) It puts a premium on laziness.

(2) It encourages careless and incomplete surveys and plans.

A moment's consideration shows why the percentage system encourages sloth. Obviously the slower the employee works, the more the job costs, and, the more it costs, the greater are the contractor's profits.

As an illustration, the writer recalls seeing a large open cut railway excavation in progress near New York City, a few years ago, where drilling was being done by hand. This in itself was bad enough, but to make things worse, the drill holes were spaced not more than 2 ft. apart, and often less. One acquainted with rock work and with the percentage system has not to be told that this was a percentage contract. Unquestionably this particular instance marked the extreme of this form of grafting, but none the less it shows the basic defect of the percentage system.

To escape this defect the fixed fee system was devised. Under the fixed fee system, the contractor has no object whatever in so handling or mishandling his work as to run up its cost, for his profits are a fixed fee or commission and not a percentage. Indeed, he has strong incentives to keep down the cost, in order that he may secure repeat orders, as well as be able to refer prospective patrons to those for whom he has done work in the past.

The fixed fee system, possesses all the advantages of the percentage system, together with certain merits of its own, most important of which is the incentive for the engineer and contractor to combine their knowledge in an effort to reduce costs. Mr. C. H. Eglee presents these advantages admirably in his letter, which appears elsewhere in this issue.

The fixed fee system has the advantage of stimulating the contractor to exert himself

to complete the job quickly, so as to free his organization and his plant for use on other jobs.

All these are powerful arguments in favor of the fixed fee system. Why, then, should it not be adopted universally for all classes of construction work? Mr. Eglee contends that it should be and will eventually be adopted instead of the competitive system now commonly in vogue. Let us consider, however, the defects in the fixed fee system before we agree to throw over the competitive system, boots and baggage.

We are agreed that the fixed fee system is far superior to the percentage system, but we must not overlook the fact that it possesses one serious drawback when contrasted with the competitive system, namely that it does not offer as great an inducement to invent or introduce labor-saving machines or methods.

It is true that the fixed fee contractor is anxious to save money for his client, but was there ever a man so anxious to save money for his customer as to save it for himself? The great actuating motive of business life to-day may be called selfishness, but selfishness is, in final analysis, the scourge that has driven men onward and upward since the time of Adam. Selfishness is not merely the mother of competition, it is both father and mother. The desire to excel, to win the praise of men, is simply selfishness, somewhat disguised it's true, but selfishness none the less.

The spur of competition urges the Marathon runner to victory. It rowels the flanks of genius to excel itself. The very word genius would have no significance were it not for competitive strife. Praise, glory and power are nothing but rewards for excellence, and excellence has no meaning, save as a mark of superiority in competition.

So inrooted is this fundamental principle of competition that the games with which we while away an hour or two are nothing else than competition. Nor does it take any stretch of philosophy to prove that every laugh is an evidence of self-recognized superiority over some person or condition, actual or imagined.

Where so powerful an agent as competition is at work, abuses must inevitably spring up. Games must be governed by rules to secure fair play. Business must be controlled by governmental laws. Contract work must be guarded by specifications. The infractions of these various rules, laws and specifications often call forth denunciation of games, laws and contracts as being themselves at fault. "Dirty work" in football, however, is not likely to kill the game. Nor will "dirty work" in competitive contracting destroy this time-tried system of doing work.

The Socialist, seeing only the "dirty work" in business relations, decries competition in its entirety; but he, too, is certain to be overwhelmed by the final judgment of men.

If we analyze the underlying reason for the superiority of the fixed fee system, we find that it is found in the greater competition that comes into play under the fixed fee system. Each fixed fee contractor will, of necessity, have to compete against other contractors doing work under the same system. He is alert, therefore, to work with energy if he hopes to be recommended for future work of similar character. But while he is alert, he is not ordinarily so alert as the contractor who is doing work under the old competitive system. This arises from the reason above stated, that a man will work more energetically to save money for himself than for his employer. Moreover, the weekly meeting of pay rolls in his own hard cash is an ever-recurring stimulus to exertion that does not exist in the fixed fee system.

So much for the relative advantages and disadvantages of these two systems of contracting, looked at from a philosophical point of view. Let us now consider the conditions that should determine which of these two systems is to be selected in any given case.

We believe that the old fashioned competitive, unit price, contract system should be chosen wherever the actual conditions to be encountered, and actual quantities of work involved are ascertainable in advance, at a moderate cost for such ascertainment.

We believe that where these conditions or quantities can not be thus ascertained, the fixed fee system should be selected.

Practically all road and pavement construction falls immediately into the class of work that is best done under the unit price, competitive contract system. The greater part of railroad construction likewise falls naturally into this class.

On the other hand, difficult tunnel work and foundations, many classes of dam work, and a great part of architectural work falls naturally to the fixed fee contractor.

Tunnels must frequently be driven through materials of doubtful character. In which event, a unit price contractor is likely either to go broke or to make an unreasonably large profit.

Dams are usually subject to floods during construction, and are often built where the cost of the foundations is problematical. Therefore dam building lends itself admirably to the fixed fee system of contracting.

Architectural work is notoriously subject to change of design even after the plans are drawn, and it also happens frequently that time is an element of such importance that construction work should begin before the plans are completed. Hence it is that the fixed fee system has become justly popular with many architects.

In conclusion, let us add that the objections to the competitive contract system, as a *system*, are objections which can be largely eliminated by the American Society of Engineering Contractors.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Methods of Constructing Concrete Vaults for Valves.

BY CARROLL BEALE.*

The system of concrete construction for valve casing foundations described and illustrated here has been in successful operation in the District of Columbia for nearly a year. The foundation, Fig. 1, consists of concrete rings 3 ft. in diameter, 8 ins. and 4 ins. high, 3 ins. thick and reinforced with 16-gage expanded metal. These rings have proven to be not only more economical than the old brick construction, but the department is now enabled to build a foundation in five minutes, whereas with the brick construction one whole day was required by a bricklayer and his force to construct a foundation 4 ft. deep.

To illustrate the economy of these rings, take for example a masonry foundation 4 ft. deep of brick. This required the services of a bricklayer and force one day of eight hours. The bricklayer's force account and material used were as follows:

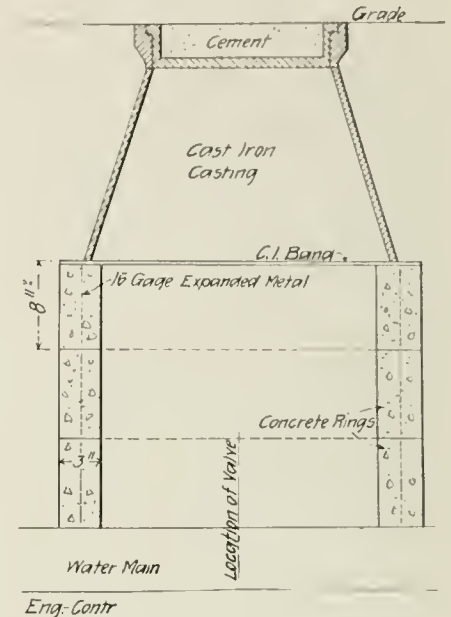


Fig. 1—Foundation for Valve Casing Built of Concrete Rings.

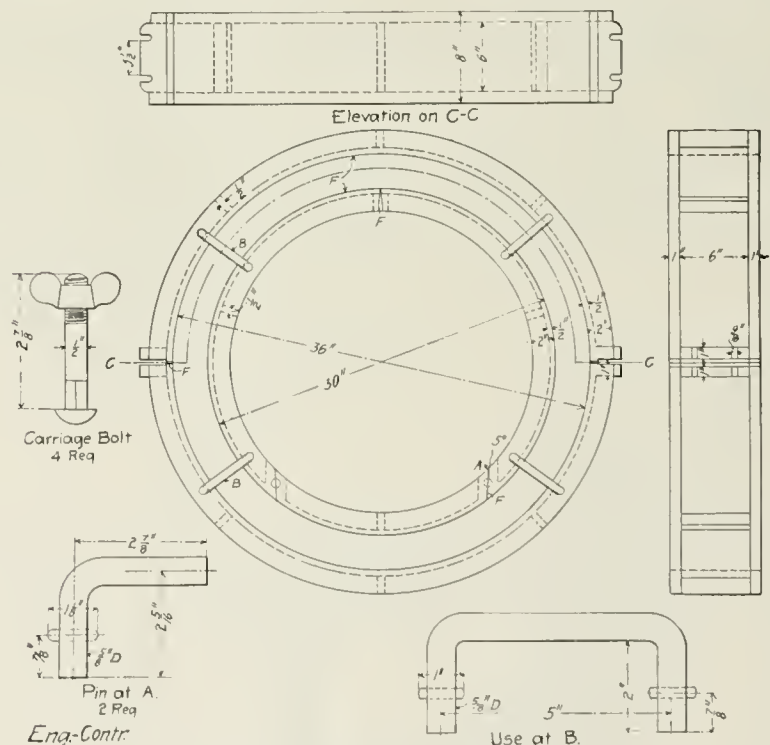


Fig. 2—Cast Iron Form for Vault Rings.

1 bricklayer at \$5 per day.....	\$ 5.00
2 laborers at \$1.75 per day.....	3.50
Cart and driver \$2.25 per day.....	2.25

420 red brick at \$9 per M.....	3.78
¾ bbls. of Portland cement at \$1.79.....	1.31
⅓ cu. yd. sand at \$1.20.....	0.40

*Engineer in charge of Miscellaneous Construction, Department of Water, District of Columbia.

Total\$16.24

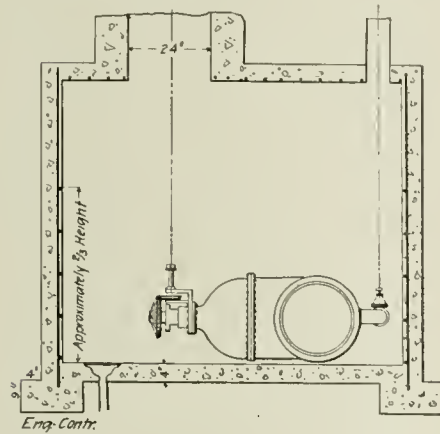
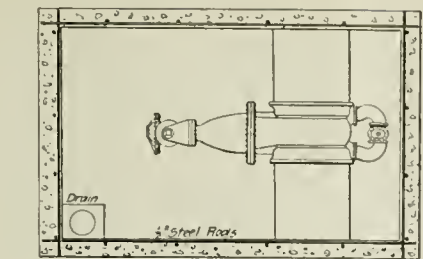


Fig. 3—Concrete Vault for Horizontal Valve.

For a 4-ft. foundation of concrete, six 8-in. rings are required. These rings in place cost 50 cts. each; therefore the cost would be \$3, as against \$10.24 for the brick construction. It is therefore demonstrated that the cost of the concrete foundation is less than 20 per cent the cost of the old brick construction, not taking into consideration the time lost by the bricklayer in moving about the city.

The ring 8 ins. high cares for a height formerly occupied by 6 sq. ft. of brickwork 9 ins. thick, or 72 brick, which at \$9 per M. is equal to 65 cts., so it may readily be seen that the cost of these rings is less than the cost of the brick alone without mortar and without labor, which last item amounted to \$10.75 per day current expense.

An itemized cost of the rings is as follows:

0.0767 bbl. of cement = 1/13 bbl.

0.048 cu. yd. gravel = 1/20 yd.

0.024 cu. yd. sand = 1/40 yd.
The cost of one ring therefore is:

	Cts.
Concrete	25
Labor	7
Steel	16
Total	48
Placing	2

Total for ring in place.....50

To sum up the relative merits of the brick and concrete construction the use of concrete saves the department a current expense of \$10.75 per day, avoids the delays attending brick construction, is as

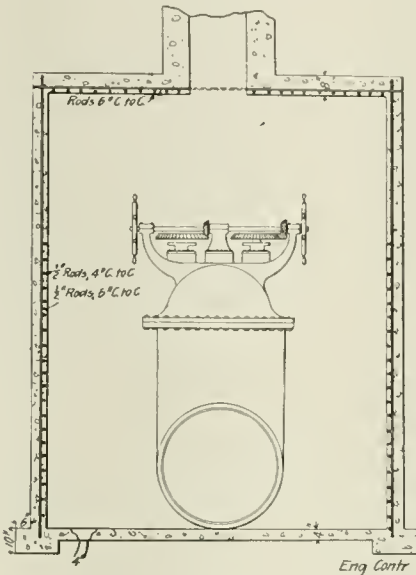


Fig. 4—Concrete Vault for Vertical Valve.

readily removed as the brick, and is much stronger.

These rings are made in the cast iron forms shown by Fig. 2, on a smooth platform and one man is able to make four 8-in. rings in one hour.

As illustrative of the economy in reinforced concrete vault construction, the accompanying drawings, Figs. 3 to 5, and Table I, give examples of the types of vaults now being constructed in the Dis-

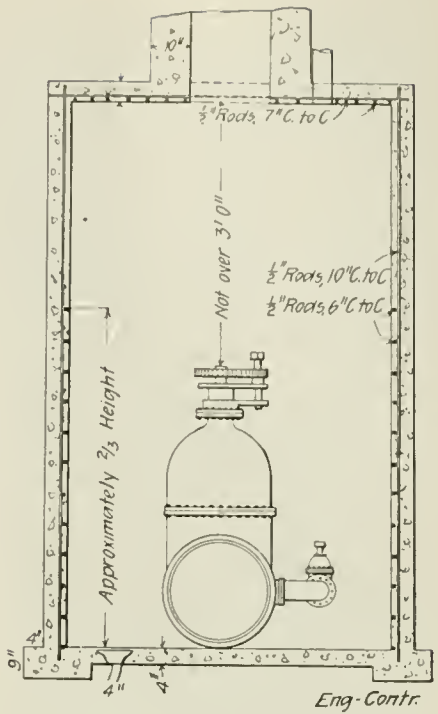


Fig. 5—Concrete Vault for Vertical Valve.

trict of Columbia. Three of these vaults 5 ft. 10 ins. by 5 ft. 6 ins. by 11 ft. 7 ins.; 5 ft. 9 ins. by 5 ft. by 9 ft., and 6 ft. 2 ins. by 8 ft. 10 ins. by 6 ft., have just been completed at New Jersey Ave. and B St., just north of the United States Capitol, at a cost of \$50 each, excluding the cost of the lumber which will be reused. The roofs of these vaults have an ultimate strength of about 3,500 lbs. per sq. ft., and the flat construction permits of at least 2 ft. more head room than can possibly be had where a brick arch is used. This last is a very important item where the mains are shallow and where every inch of head room counts. The vaults may be constructed for approximately one-third the cost of the brick vaults and have a much greater factor of safety than the old brick vaults using 13-in. walls. The drawings and tables explain fully the method of construction without further description. The speci-

TABLE I.—SHOWING DIMENSIONS AND QUANTITIES FOR REINFORCED CONCRETE VAULTS FOR HORIZONTAL VALVES, WASHINGTON, D. C.

Size of Valve, ins.	Depth to Bottom of Main, ft.	Nominal Dimensions of Vault	Height of Vault Inside, ft.	Thickness of Roof ins.	Thickness of Walls, ins.	Spacing C. to C. of Rods in Roof, ins.	Spacing of Horizontal Rods in Walls.		Spacing of Vertical Rods, ins.	Cu. Yds. of Concrete.	Cu. Yds. of Sand.	Cu. Yds. of Gravel.	Bbls. of Cement.	Cu. Yds. of Excavation.	Horizontal Rods in Walls.				Rods in Roof.		Vertical Rods.			
							Long Span,	Short Span,							Long Spans		Short Span		No.	Lnth: Feet.	No.	Lnth: Feet.	No.	Lnth: Feet.
															No.	Lnth: Feet.	No.	Lnth: Feet.						
20 and 24	5	8 x 5	4	4 1/2	5	5 1/2	24	33	24	4 1/2	12 1/2	3 1/2	6	10 1/2	66	9	6	6	18	6	15	7		
20 and 24	6	8 x 5	4	4 1/2	5	5 1/2	24	33	24	4 1/2	12 1/2	3 1/2	6	10 1/2	66	9	6	6	18	6	15	7		
20 and 24	8	8 x 5	4	4 1/2	5	5 1/2	18	25	20	6 1/2	12 1/2	5	8	16	10	9	8	6	21	6	18	9		
20 and 24	10	8 x 5	4	4 1/2	5	5 1/2	12	17	16	7 1/2	6 1/2	10	8	20 1/2	16	9	12	6	21	6	22	11		
20 and 24	12	8 x 5	4	4 1/2	5	5 1/2	10	14	12	8 1/2	7 1/2	12	8	25	22	9	16	6	24	6	29	13		
30 and 36	6	11 x 5	5	5 1/2	6	6 1/2	18	33	24	6 1/2	12 1/2	5 1/2	8	16	12	6	6	6	30	6	18	7		
30 and 36	8	11 x 5	5	5 1/2	6	6 1/2	16	21	20	6 1/2	12 1/2	5 1/2	10	21 1/2	10	12	9	6	30	6	22	9		
30 and 36	10	11 x 5	5	5 1/2	6	6 1/2	12	16	16	10	10	8	13	26 1/2	16	12	12	6	34	6	27	11		
30 and 36	12	11 x 5	5	5 1/2	6 1/2	6 1/2	10	13	12	12 1/2	10 1/2	16	13	31 1/2	20	12	14	6	34	6	35	13		
30 and 36	14	11 x 5	5	5 1/2	7 1/2	7 1/2	8	10	11	14 1/2	12	18	16	36 1/2	30	12	24	6	34	6	41	15		
48	8	13 x 6	6	6	6	6	14	28	20	10	4 1/2	8 1/2	13	30	10	14	8	7	39	7	25	9		
48	10	13 x 6	6	6	6	6	10	20	16	12	10	10	16	37 1/2	18	14	10	7	39	7	31	11		
48	12	13 x 6	6	6	6	6	8	16	13	14 1/2	12	12	18 1/2	44 1/2	26	14	14	7	39	7	37	13		
48	14	13 x 6	6	6	6 1/2	6 1/2	6	10	10	16 1/2	14	22	22	52	40	14	24	7	45	7	43	15		
48	16	13 x 6	6	6 1/2	7 1/2	7 1/2	6	9	8	19 1/2	5	16	25	60	48	14	30	7	45	7	50	17		

cations for concrete and reinforcement are as follows:

Concrete shall consist of a mix of 1 part Portland cement, 2 parts coarse sand and 4 parts clean gravel 1½ ins. and under. Forms shall consist of a frame work of 4x4-in. uprights securely fastened together, 21 ins. c. to c. and braced top and bottom. Loose horizontal boards 2x12 ins., dressed one side, shall be laid against the uprights and the concrete brought up and tamped 1 ft. at a time. When the concrete has set the frame work shall be taken apart, the forms taken down and used elsewhere. Steel rods to be ½ in. square and of some type that will furnish an absolute mechanical bond with the concrete.

Cement and sand shall first be mixed dry until the mix becomes a uniform color and then water shall be added until the mass becomes the consistency of ordinary cement mortar. The gravel shall be well wetted before being used. Add the gravel and turn the mass until all the ingredients become thoroughly incorporated and the desired consistency is reached. Tamp the concrete in layers not exceeding 12 ins. in height and under no conditions should the roof be started unless it may be finished the same day.

A new bridge is to be erected over the Mississippi River at Keithsburg, Ill., on the Iowa Central R. R. to replace the present structure at that point. The bridge will have a novel feature in that the usual draw span will be dispensed with and a lift span substituted. With this span arrangement there will be two towers connected to the ends of the spans next to the spans that are to be lifted. Several of the spans are so arranged that these towers can be placed on them and the intermediate span lifted; this will allow for the channel shifting. There will be 23 piers and possibly 27, and 4 abutments. There will be ten 200-ft. spans, and two spans of 103-ft. girders, and 22 spans of 67-ft. girders. The weight of the steel approximates 4000 tons. The Union Bridge & Construction Co., Kansas City, Mo., has the contract for putting in the sub-structure and erecting the superstructure. The McClintock-Marshall Co., Pittsburg, Pa., will provide the steel.

Pig-iron production for the 30 days of September, 1,118,998 gross tons, showed the largest monthly production of the year, though falling about 35 per cent short of the September, 1907, figures. The production figures for the nine months of the year, 10,755,573 gross tons, were about 46 per cent below corresponding 1907 figures.

The production of quicksilver in the United States in 1907 was 21,567 flasks, of 75 lb. each, and was valued at \$828,931. As compared with the production of 1906 this shows a decrease of 1,671 flasks in quantity and of \$129,703 in value.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost of Drilling Holes with a Well Drilling Machine.

The following is a record of some holes drilled, and the cost of drilling them, at Mussellsell and Roundup, Montana, for the Republic Coal Co. of Chicago, Ill.

The work was done with a No. 2 Cyclone drill, manufactured by the Cyclone Drill Co., of Orrville, Ohio. The machine was equipped with hollow rod tools. This machine is meant to drill holes from 500 to 700 ft. deep; it is equipped with a 7 h. p. engine run with gasoline. Holes from 23 ft. to 517 ft. were drilled. The bits used were 2½ ins. Two men, the drill runner and a helper, were employed on the machine. The work was done in prospecting. The record of each hole is given in the table.

Hole No.	Depth.	RECORD OF HOLES DRILLED.	
		Average drilled per shift.	Material.
1	391 ft. 7 in.	39 ft. 1 in.	Shale and sandstone.
2	293 ft.	36 ft. 7 in.	Shale and sandstone.
3	284 ft.	47 ft. 4 in.	Shale and sandstone.
4	347 ft.	49 ft. 7 in.	Shale and sandstone.
5	103 ft.	51 ft. 6 in.	Shale and sandstone.
6	297 ft.	42 ft. 5 in.	Shale and sandstone.
7	36 ft. 6 in.	52 ft.	Soil and gravel.
8	23 ft. 11 in.	32 ft.	Soil, gravel, shale.
9	51 ft. 8 in.	47 ft. 8 in.	Soil, gravel, shale.
10	27 ft. 3 in.	33 ft.	Soil, gravel, shale.
11	53 ft. 5 in.	30 ft.	Soil, gravel, shale.
12	517 ft.	36 ft. 11 in.	Shale and sandstone.
13	463 ft.	57 ft. 5 in.	Shale and sandstone.
Total	2885 ft. 4 in.	41 ft. 10 in.	

In all, 69 days were worked, making the average nearly 42 ft drilled per 10 lb. shift, as shown in the table.

The cost of the work is shown below. A two horse team was used to haul water and other supplies. The machine used 4 gals. of gasoline per day. It will be noticed that the cost of the team was nearly 50 per cent of the total cost.

Drill Runner, 69 days @ \$2.50.....\$172.50
 Helper, 69 days @ \$2.00..... 138.00
 Team, 69 days @ \$1.00..... 276.00
 276 gals. gasoline @ 12 cents..... 33.12

Total\$619.62

This gives a cost of 21½ cents per ft. of hole. To this should be added an allowance for plant and superintendence. It will be noticed that some of the holes are very shallow, thus necessitating frequent moves of the machine.

Coal valued at \$614,798.898 was produced in the United States in 1907.

Dredging Earth and Rock at Panama.

The dredges working on the Atlantic division of the Panama Canal, although seemingly working in a swamp, have found that the earth, although only a few feet above mean sea level, is very firm and underneath this earth at varying depths is a bed of blue rock, coming close to the surface in several places and in others lying 10 ft. or more below. The method of working in this material is to blast it with dynamite and then take it out by ladder and dipper dredges. A battery of nine Star drills precedes the dredges, keeping far enough in advance not to retard the work. The bottom of the canal from the Limon bay to Gatun Locks is to be 41 ft. below sea level, and, as the surface of the ground is from one

to five feet above sea level, the holes for the dynamite are from 45 to 50 ft. They are sunk at 15 ft. intervals in the form known by powder men as "staggered" and are not sprung before the dynamite is put in. At present 60 per cent dynamite is being used and the charge varies according to the depth of the hole in rock, the object being to shatter the rock. There was some doubt as to whether the rock could be broken into pieces small enough for the dredges to handle, but so far this method has proved entirely successful. The channel has already been dug 1,000 ft. into the bank the full width of 500 ft. and the dredges are making a cut that varies in depth from 20 to 40 ft. All the ladder and dipper dredges are working in rock, and although some large pieces are brought up nothing has been encountered so far that the dredges can not handle.

Dredge No. 6, one of the old French ladder type, is working close to the bank.

It is handling rock and the overlying strata of earth and is cutting to a depth of from 20 to 30 ft. The dipper dredge Chargres is doing the most interesting class of work, because it is taking rock up from 30 ft. or more below sea level. This dredge is capable of excavating to the full depth required, 41 ft., and up to the present time the rock encountered has been broken into sufficiently small pieces to be handled without much difficulty. The Chargres and dredge No. 6 are the ones working farthest in toward land, following very closely on the heels of the powder men. As they advance they may strike harder rock and material more difficult to handle, so that the cost cannot be fairly estimated, but at present they are handling blue rock shattered by dynamite at a cost of only 80 cts. per cu. yd.

Dredge No. 85, new 20 in. suction, is working a few hundred yards back of dredge No. 6, in silt. The end of the pipe line rests on a small island near the mainland, several hundred yards away from the line of the channel. Behind this dredge is the old French ladder dredge No. 1, and back of this the dipper dredge "Mindi." The "Mindi" is working in coral which has been broken by exploding dynamite on the surface of the rock in the manner known to powder men as "bull dozing."

Cost of Canal Excavation and Concrete Work for Uncompahgre Irrigation Project, Colorado.*

The work covered 4,400 lin. ft. of which is known as the South Canal, which was begun in June, 1907, and completed in May, 1908, at a total cost of \$22,932. The canal has a bottom width of 40 ft., side slopes of 2 to 1, water depth of 8.3 ft., and a discharge capable of 1,175 second-feet.

Class 1 excavation contained all material that could be plowed by an average six-horse team, each animal weighing not less than 1,400 lbs., attached to a suitable breaking plow, and also all isolated masses of rock not exceeding $\frac{1}{2}$ cu. yd. in volume. Class 2 excavation consisted of material originally of the nature of Class 1, but so saturated with water as to render the use of teams in the ordinary manner impossible. Class 3 excavation consisted of indurated material of all kinds that could not be plowed as Class 1 or that required loosening with powder before being removed in scrapers and also all loose material in which large rocks occurred to such an extent as to prevent the use of plows and scrapers, excluding masses exceeding 1 cu. yd. in volume. Class 4 excavation consisted of rock in masses greater than 1 cu. yd. in volume and requiring drilling and blasting before removal. The limit of free haul was 300 ft. About 73 per cent of the material was removed with slip, Fresno and wheel scrapers, about 27 per

cent with a slip and chain, and the remainder with shovels and wheelbarrows.

Class 1 concrete included all concrete laid in thicknesses of 12 ins. or less and in which the gravel or broken stone did not exceed 1 in. in dimension. Class 2 concrete included all concrete laid in masses greater than 12 ins. in thickness. The gravel or broken stone in this class of concrete was required to be less than $2\frac{1}{2}$ ins. in any dimension except in walls having a thickness of 2 ft. or more, in which fragments of perfectly sound rock not exceeding 6 ins. in any dimension were placed by hand. These fragments were so placed as not to come nearer than 6 ins. to any surface or wall or nearer than 4 ins. to each other. All cement for fabrication of concrete was furnished by the United States at Lujane, Colo., and had to be hauled 12 miles to the work. The other materials for the concrete were obtained less than one mile from the work. In Class 2 concrete a considerable amount of rock was placed in the concrete for the purpose of saving the cement. The backfilling was done by hand during the rainy weather, thus saving the cost of water usually necessary for this character of work.

TABLE SHOWING COSTS OF EXCAVATION AND CONCRETE WORK ON 4,400 FT. OF IRRIGATION CANAL, UNCOMPAHGRE PROJECT, COLORADO.

Distribution of cost.	Excavation			Concrete				
	Class 1 24,194 cu.yds.	Class 2 15,054 cu.yds.	Class 3 17,058 cu.yds.	Class 4 100 cu.yds.	Over- haul 6,600 cu.yds.	Class 1 32.4 cu.yds.	Class 2 72.4 in., 145 lin.ft.	Back- filling 29 cu.yds.
Interest	\$0.002	\$0.005	\$0.003	\$0.006	.....	\$0.02	\$0.02	\$0.012
Plant depreciation.....	0.002	0.006	0.004	0.008	.....	0.02	.02	0.017
Executive	0.028	0.070	0.048	0.062	\$0.002	1.50	1.34	\$0.05
Labor	0.197	0.503	0.339	0.439	0.015	2.24	2.00	0.25
Supplies .....	.....	0.002	0.001	0.260	.....	0.92	0.97	.....
Contractor's total cost.....	\$0.229	\$0.586	\$0.395	\$0.775	\$0.017	\$4.70	\$4.35	\$0.30
U. S. materials.....	.....	.....	.....	.....	.....	\$2.96	\$2.16	\$1.22
U. S. engineering.....	\$0.013	\$0.009	\$0.012	\$0.001	\$0.001	\$0.34	\$0.45	\$0.03
Total actual cost.....	\$0.242	\$0.595	\$0.407	\$0.776	\$0.018	\$5.00	\$6.96	\$1.55

The weather conditions were good for the performance of work throughout the continuance of the contract, and the management was good with exception of insufficiency in the number of foremen employed. Labor was scarce and high. Laborers were paid on the concrete work at the rate of \$2.36 per 8-hour day. On the excavation laborers were paid at the rate of from \$2.25 to \$2.50 per day; foremen at the rate of \$3 per day and the superintendent at the rate of \$122.50 per month.

The unit costs of the different classes of work are given in the accompanying table.

The Ministry of Ways of Communication has asked the Russian Government for \$41,000,000 for new railway construction. Out of this amount are to be taken the funds for building the Amur road, double tracking the Siberian road, building a bridge across the Volga at Yaroslaff and connecting the Russian and Finnish railway systems at St. Petersburg.

The production of silver in the United States in 1907 amounted to 56,514,700 ounces, valued at \$37,299,700.

A Novel Type of Dredge for Drainage Ditching With Some Records of Its Operations.*

In the spring of 1907 two "walking" dredges were built at Stephens, Minn., and worked throughout the summer in the Red River Valley. These machines were duplicates and one of them was visited on Oct. 19. This machine consisted of a timber hull with overhead trussing and thoroughly braced, which stood across the constructed ditch. On the floor of this hull was placed the operating machinery. On the front end were an A frame and false mast, which supported a 40-ft. boom. On the rear of the hull was a 50-HP. Fairbanks-Morse gasoline engine. The boom was swung by a turn-table similar to the ordinary dipper dredge. The shovel or digging part of the machine is similar in shape to a slip scraper, being 6 ft. wide at the widest part and when full holds about $1\frac{3}{4}$ cu. yds. of earth. The shovel is attached to a frame known as the walking beam on the front end of the boom (Fig. 1). This machine, in solid ground, could dig a ditch 20 ft. deep and 32 ft. wide on top. The boom will dig or dump earth at its full length. The machine

is electric lighted for night work. The crew consists of 1 foreman, 1 team and teamster, 1 engine man, 1 crane man and 1 shoveler. For night work 3 additional men are carried, each shift working 11 hours. At the time the machine was visited, each shift was making, approximately, 400 ft. of ditch with a 6 ft. bottom, 5 ft. deep and $1\frac{1}{2}$ to 1 slope. The preceding week they had moved 12,000 cu. yds. in six days of 22 hours per day. Seventy-five gallons of 74 per cent gasoline is used each 22 hours.

The peculiarity of this machine is the method of moving. Under each corner is a timber platform the shape of a stone boat, called a foot. Each of these corner feet is 6 ft. wide, 8 ft. long and 4 ins. thick. They are joined together transversely by a light timber. This required them both to move in the same direction, the direction being controlled by a chain which runs from each corner foot to a drum that is operated by the crancman. Near the outside of each corner foot there is a knife made of iron, $\frac{1}{2}$ in. thick by 6

*Extract from Bulletin No. 110, Northwest Experiment Farm, University of Minnesota, Crookston, Minn.

*Rearranged from the "Reclamation Record" for November, 1908.

ms. wide and 6 ft. long, which prevents the foot slipping sidewise. Midway of the machine on either side is a center foot 6 ft. wide, 11 ft. long and 6 ins. thick. On the under side a 6x6-in. timber is bolted crosswise, to prevent slipping back. This foot is attached to a heavy triangle frame, free to move longitudinally between the double side frame of the hull. A chain, the end of which is attached to the side timbers of the hull passes over two pulleys in this triangular frame and then passes along the hull to the back carrier and across the back end to a drum which is located about the center of the hull. When it is desired to move the machine the power is turned onto this drum and the chain wound up. As the chain tightens the hull of the machine rises, the weight coming on



Fig. 1—Shovel of "Walking Dredge."

the center foot. The winding on the drum is continued until the weight in lifting the hull becomes greater than the friction at the corner post, where the entire hull moves ahead about 6 ft., although an 8-ft. move can be made. The chain is then released, taking the weight off the center foot, which is pulled ahead by another chain attached to a drum in the front part of the hull.

This machine when not digging has moved across country at the rate of 1 mile in 11 hours. While working, the machine threw 7 shovels of dirt and moved ahead 6 ft. 8 ins. in 7 minutes. It worked at this rate several times and this seemed to be about an average speed. Short turns cannot be made, as the feet are liable to slip into the ditch and wet caving material causes trouble. Where the banks are dry and firm, there was no difficulty in moving.

The field of this machine is in comparatively level ground, which is not too soft.

Excavation on the Isthmian Canal during October totaled 3,282,276 cu. yds.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Labor Cost of Constructing Eight Macadam Roads and Data on the Average Labor Cost of Macadam Construction.

In 1906, the Illinois Highway Commission, Mr. A. N. Johnson, State Engineer, began the construction of experimental macadam roads. Much interest was manifested in these experimental roads and the Commission received many requests for the construction of similar roads. As a result several additional experimental macadam roads were built in 1907. In general, the plan of co-operation with the local communities was that they should furnish all labor and pay freight on the crushed stone, which was furnished free at the State prison crushers. The Highway Commission supervised the work and furnished a steam roller and sprinkling cart without cost to the local people. In a few instances the freight was paid in ballast.

In our issue of April 10, 1907, we described the method of construction employed for the experimental roads in 1906, and gave the labor cost of the work. In this article we give the labor cost of the experimental roads constructed in 1907, the matter having been taken from the 2nd annual report of the Illinois Highway Commission.

The method of construction was the same as that on the 1906 roads. The small size stone—1½-in. size—was placed as the bottom layer, on which was spread the 3-in. material bonded with screenings. Each layer was rolled thoroughly, as well as the road bed. Blind side drains were cut through the shoulders every 50 ft. on each side of the road. These drains are necessary where the shoulders are made of clay or other soil retentive of moisture, and are a very important feature of the construction.

A comparison of the cost of the work done in 1907 with that of 1906 shows, in general, an increase, which may be accounted for by the fact that in no instances in the past year has the work proceeded with dispatch. This was occasioned by two features which were beyond control, either of the State Highway Commission or of the local people who were interested in building the various roads. The first of these was bad weather, which frequently stopped the work for a week or more at a time. The second was the irregular shipments of the material from the penitentiaries, on account of the inability to secure cars when needed. There were times on some of the jobs when but a few cars of stone were received in a month.

First Street Road, DeKalb, DeKalb.—The road selected at DeKalb for experimental work during 1907 is located one-half mile south of DeKalb, beginning at the end of the brick pavement and extending south 4,770 ft. on what is known as South First St. This road had been constructed of macadam by the local highway commissioners, with the co-operation of the U. S. Office of Public Roads, as an object lesson in 1904. The reason it was necessary to resurface this road so soon is that the material of which it was built was a rather soft limestone, the 1½-in. size being used for a wearing surface, which was not sufficient to sustain the heavy traffic which was confined entirely to one track. As a result, deep ruts had formed and also some chuck holes, so that the surface was in such a bad condition that it required reconstruction.

The new surface which was put upon the road was composed of stone shipped from the Joliet penitentiary, using the 3-in. material. The old surface was broken up to a width of 12 ft. by spikes placed in the wheels of the steam rollers. Shoulders were formed on the sides by a road grader. The loosened material of the old road was shaped to give a 1-in. to the foot crown. After being thoroughly harrowed, to allow the small material to sift to the bottom, it was thoroughly rolled. On this, as a foundation, was laid a 6-in. course of 3-in. material, which was rolled and bonded with stone dust.

The money for this work was provided from the town funds. The work was begun on Nov. 18 and completed on Dec. 17, the actual number of working days being 18. The quantities and amount of labor cost of the resurfacing are as follows:

Length of road.....	4770 ft.
Width of macadam.....	12 ft.
Cubic yards of stone.....	760
Square yards of macadam, resurfaced	6360
Average haul	1½ miles.
	Per 9-hr. day.
Labor, men	\$2.25
Labor, men with teams.....	4.50
The cost of the work was as follows:	
Spiking up	\$15.00
Harrowing	2.43
Excavation	19.87
Unloading stone	38.25
Hauling stone	370.00
Spreading stone	44.00
Trimming shoulders	28.25
Rolling, coal and sprinkling.....	100.00
Superintendent and watchman.....	60.00
Total	\$670.71

The cost per cubic yard of placing stone was:	Per Cu. Yd.
Unloading stone	\$0.050
Hauling stone	.486
Spreading stone	.057
Rolling, coal, men and sprinkling....	.154

Total\$0.747
The labor cost per square yard was:

	Per Sq. Yd.
Excavation	\$0.001
Placing stone	.088
Trimming shoulders	.003
Superintendent and watchman.....	.010

Total\$0.105

(2) *Effingham Road, Douglas Township.*—This road, known as the Effingham-Siegal road, extends one mile north of the city limits, crossing the Illinois Central Railroad and passing the cemetery. The grades do not exceed 2 per cent. A 4-ft. by 4-ft. concrete culvert was built to accommodate a small stream. It was not necessary to use tiling, as the ground drained readily, the soil being a light prairie loam.

The money was furnished by the local commissioners from the township funds. The stone was donated by the state and shipped from the Menard penitentiary. The work was hindered by much rain and irregular shipments of stone caused by the delay in securing cars, and the congestion of railroad traffic. The unloading and hauling of stone was done by contract, the spreading of stone and all other work was done by day labor. This work was begun at the far end and completed towards town.

The quantities, amount of work and labor cost are as follows:

Length of road.....	5,320 ft.
Width of macadam.....	12 ft.
Square yards of macadam.....	7,093
Cubic yards of stone in road.....	2,697

Labor—men, 15 cents per hour; team and man, 30 cents per hour.

The cost of the work was:

Excavation	\$433.07
Shaping road bed.....	233.92
Unloading and hauling stone.....	471.79
Spreading stone	264.38
Trimming shoulders	50.96
Rolling, water, sprinkling, coal, oil, repairs, etc.	358.54
Superintendent and incidental expenses	280.75

Total\$2,093.41

The unit cost of placing stone per cubic yard was as follows:

	Per Cu. Yd.
Unloading and hauling stone.....	\$0.175
Spreading stone	.10
Rolling, water, sprinkling, coal, oil, repairs, etc.	.1329

Total cost per cubic yard.....\$0.408

The labor cost per square yard was:

	Per Sq. Yd.
Excavation	\$0.061
Shaping road bed.....	.033

Placing stone	.154
Trimming shoulders	.097
Superintendent and incidental.....	.040

Total cost per square yard.....\$0.295

(3) *Elburn Road, Campton Township.*—The road commences at the village limits and extends north two miles, on what is known as the Lily Lake Road. The soil is varied, the first and last quarter miles are prairie loam, and the remainder clay. The entire distance had been improved with gravel which had, however, been very largely lost by neglect and wear. Some places had been repaired by hauling in large boulders, which made a very rough surface. The country is rolling prairie and the old gravel surface was largely disregarded, as the grades were reduced by increasing cuts and fills. In places the cuts are 10 ft., while the maximum fill is about 5 ft. The stone was shipped from the penitentiary at Joliet. The work was begun at the far end and completed toward the town, which method is not to be generally recommended.

Three small, circular culverts were built in the place of wooden ones, and one 5-ft. culvert was rebuilt with a concrete top, on the old stone abutments, which were in good condition.

The work was greatly handicapped by the amount of rain, more than one-third of the time being thus lost. Another delay in the work was caused by the irregular shipment of the stone. The railroad company, being crowded with traffic, would sidetrack cars until a number had accumulated, then all would be sent in at once. This multiplied the trouble, for just as likely as not cars were delayed when the weather was fair and shipped when the weather was bad. These unavoidable delays necessarily increased the cost of the work.

The quantities, amount of work and labor cost are as follows:

Length of road.....	10,560 ft.
Width of macadam.....	12 ft.
Square yards of macadam in road.....	14,080
Average haul of stone, 1½ miles.	
Cubic yards of stone.....	6,400

Labor—Men, 20 cents per hour; team and man, 40 cents per hour.

The cost of the work was:

Excavation	\$1,234.20
Shaping road bed.....	443.00
Trimming shoulders.....	128.00
Unloading stone	419.20
Hauling stone	2,021.20
Spreading stone	361.80
Rolling, oil, coal, supplies and sprinkling	667.00
Superintendence and watchman...	516.00
Concrete bridges	123.00

Total\$5,913.40

The unit cost per cubic yard of placing stone was:

	Per Cu. Yd.
Unloading stone	\$0.065
Hauling stone	.316

Spreading stone ..	.056
Rolling	.104

Total\$0.541

The labor cost per square yard finished macadam was:

	Per Sq. Yd.
Excavation	\$0.087
Shaping road bed.....	.031
Trimming shoulders	.010
Placing stone	.246
Superintendence and watchman.....	.036
Concrete work	.010

Total\$0.420

(4) *Lincoln Road, East Lincoln Township.*—The experimental road at Lincoln leads east from the city limits a distance of two miles, and is known as the East and North Lincoln Road. The country is slightly rolling, the grades not exceeding 2 ft. in the hundred. The stone was shipped from the Joliet penitentiary. The freight on this shipment was paid in ballast delivered to the railroad company.

The local commissioners paid the cost of the concrete culverts and the grading, while the unloading, hauling and spreading of stone was paid by subscription, as well as the handling of the shale used in the foundation. The subscription was raised by a local improvement association formed for this particular purpose and much credit is due those who had this matter in hand and gave so liberally both in time and money.

The construction was made 12 ft. wide, 11 ins. deep, of which the lower course of 6 ins. was made of shale from the dump of a coal mine, which handled easily and compacted to form a firm base; the top course was made of 3-in. limestone.

A part of the stone preceded the road work and was placed in storage piles. This, to some extent, facilitated the work, but added to the cost of handling the stone. The work was much delayed by rainy weather and consequent condition of the road, which made it impossible for weeks at a time to haul any material.

The quantities, amount of work and labor cost are as follows:

Length of road.....	11,270 ft.
Width of macadam	12 ft.
Square yards of macadam.....	15,027

(shale base.)

Average haul of stone, 2 miles; shale, 1½ miles.

Cubic yards of stone in road, 3,658; shale, 3,160.

Labor—Men, 17½ cts. per hour; team and man, 35 cts. per hour.

The cost of the work was:

Excavation	\$75.43
Shaping road bed.....	379.04
Unloading stone from cars.....	508.25
Hauling stone	1,735.13
Spreading stone	471.82
Loading shale	383.82
Hauling shale	1,044.77
Spreading shale	293.42
Trimming shoulders	245.25

Rolling, coal, oil, supplies, sprinkling	\$63.00
Hardware, tools, superintendence, etc.	583.55
Total	\$6,683.01

The unit cost of labor per cubic yard was: Per Cu. Yd.

Unloading stone	\$0.138
Hauling stone	.174
Spreading stone	.129
Unloading shale	.121
Hauling shale	.33
Spreading shale	.092
Rolling and sprinkling (both materials counted as all stone)	.141

Total	\$0.793
Total labor cost placing stone	\$0.742
Total labor cost placing shale	.544

The cost per square yard of finished road (both materials) was: Per Sq. Yd.

Excavation	\$0.005
Shaping road bed	.026
Placing stone and shale	.359
Trimming shoulders	.016
Superintendence, watchman and water-boy	.039

Total labor cost per square yard of finished road

(5) *Hillsboro Road, Hillsboro Township.*—The experimental road at Hillsboro begins at the end of the brick pavement on Main St. and extends southeast 4,300 ft. on the old Hillsboro-Vandalia Road. This road is 12 ft. wide with a depth of stone of 10 ins. The foundation is red clay. For most of the distance the road is level, having, however, about a 3 per cent grade at its junction with the pavement. The construction of the road was made possible by the levy of a special township tax of 30 cts. per \$100.

The stone was furnished free by the state, f. o. b. cars at the Menard prison. Three reinforced concrete culverts were built on the road, of 10, 3 and 4 ft. spans, respectively. These, as well as the road, were built by day labor according to plans and specifications furnished by the State Highway Commission.

There were no serious difficulties encountered in the construction of this road, as the weather was good most of the time. One or two seepy places were found, which were taken care of by blind drains. The stone shipments, however, were extremely irregular and much time was lost on this account. Days and weeks of the best weather sometimes passed without a single car of material.

Winter stopped the work before a mile was completed. The last car of stone was dumped loosely so as to form a mud break for incoming vehicles. Next to this loose stone is a section 300 ft. long which is finished with 1½-in. stone instead of 3-in. stone.

The quantities, amount of work and labor cost are as follows:

Length of road	4,300 ft.
Width of macadam	12 ft.
Square yards of macadam	5,750
Average haul of stone, 1½ miles.	
Cubic yards of stone in road	2,500
Labor—\$2 for men, 9 hours; \$4 for two-horse team, 9 hours.	

The cost of the work was:

Excavation	\$154.65
Shaping road bed	228.25
Unloading stone from cars	215.33
Hauling stone	1,584.40
Spreading stone	203.23
Trimming shoulders	143.40
Rolling, coal, oil, supplies, sprinkling, superintendence (\$3 day)	222.00
Watchman and water-boy	253.46

Total

The unit cost per cubic yard of placing stone was: Per Cu. Yd.

Unloading stone	\$0.086
Hauling stone	.633
Spreading stone	.081
Rolling and sprinkling	.096

Total labor cost of placing stone

The cost per square yard of finished macadam was: Per Sq. Yd.

Excavation	\$0.079
Shaping road bed	.040
Placing stone	.348
Trimming shoulders	.025
Superintendence, watchman and water-boy	.082

Total labor cost per square yard of finished macadam

(6) *McLean Road, McLean Village.*—The experimental road at McLean, an extension of the road built at that place in 1906, begins at the public square in the village and extends east and south to the city limits, where it joins with the road built last year. A part of this extension was built 16 ft. wide for a distance of 515 ft., the remaining 925 ft. was built 12 ft. wide; the depth of stone was 10 ins.

This construction was somewhat difficult on account of concrete crossings and railroad tracks, to which the grades had to conform. On account of bad weather, 15 days out of 45 were lost, leaving 30 working days in which the road was building. The financing of this work was by private subscription raised by an improvement society created for this particular purpose.

The stone was furnished by the state, f. o. b. cars at the Joliet penitentiary. The work of handling stone and grading was completed just as freezing weather began and this somewhat hindered finishing the surface in the best manner.

The quantities, amount of work and labor cost are as follows:

Length of road	1,440 ft.
Width of macadam, 515 ft., 16 ft. wide	925 ft. (12 ft. wide.)
Square yards of macadam (125 sq. yds. in approaches)	2,275

Average haul of stone	700 ft.
Cubic yards of stone in road	890

Labor—Men, 25 cts per hour; teams, 50 cts. per hour.

The cost of the work was:

Excavation	\$89.00
Shaping road bed	97.00
Unloading stone from cars	136.75
Hauling stone	148.18
Spreading stone	65.20
Trimming shoulders	61.65
Rolling, coal, oil, supplies, sprinkling, superintendence, etc.	297.05

Total

The unit cost of labor per cubic yard of placing stone was: Per Cu. Yd.

Unloading stone	\$0.159
Hauling stone	.179
Spreading stone	.081
Rolling and sprinkling	.146

Total labor cost of placing stone

The labor cost per square yard of finished macadam was: Per Sq. Yd.

Excavation	\$0.039
Shaping road bed	.042
Placing stone	.205
Trimming shoulders	.027
Superintendent	.040

Total labor cost per square yard

(7) *Rock Island Road, South Rock Island Township.*—The experimental macadam road at Rock Island, known as the Cemetery Road, in South Rock Island Township, begins at the end of the brick pavement on 10th St. and extends south 4,500 ft. to the cemetery gate. The soil is light colored clay, which became very muddy in wet weather, although not particularly sticky. The land on the east side of the road rises somewhat abruptly. Towards the southern end of the road, water which collected in the hillside caused seepy places in the road, which were underdrained with tile placed at one side, and about 3 ft. below the center of the road. The macadam was built 10 ins. thick for a width of 12 ft. in the center, which is flanked by 4 ft. of macadam on either side, built but 5 ins. thick, making a total width of 20 ft. that was macadamized.

The money for this work was raised by subscription. The local commissioners also paid a proportion of the work and a small amount was paid by property owners along the road.

The stone was furnished from the Joliet penitentiary, part of the freight being paid in ballast. Approximately half of the material was shipped ahead of the work and hauled to a vacant lot near the north end of the road and stored. The work was begun in April and finished in August, 1907. The cost was increased by the long haul of the stone, which averaged about a mile and a half, by delays due to irregular shipments of material, and bad weather.

Quantities, amount of work and labor cost are as follows:

Length of road	4,500 ft.
Width of macadam	20 ft.
Square yards of macadam.....	10,000
Average haul	1½ miles
Cubic yards of stone in road.	3,800
Labor—men, per day of 9	
hrs., \$2.50; team and man	
per day of 9 hrs., \$5.	

The cost of the work was:

Excavation	\$ 301.81
Shaping road bed	175.10
Unloading stone	515.84
Hauling stone to storage	771.84
Hauling stone to road.....	481.66
Hauling stone from storage to	
road	655.21
Loading from storage.....	188.42
Hauling sand, cinders and tile....	97.83
Spreading stone	283.00
Trimming shoulders.....	337.53
Rolling, coal, supplies, oil and	
sprinkling	530.87
Superintendence	178.89
Watchman	164.10
Water boy	15.90
Tile ditching	67.39
Masonry	26.96

Total cost

\$4,792.35

The cost of placing stone per cubic yard was:

	Per Cu. Yd.
Unloading stone	\$0.135
Hauling stone to storage.....	.300
Hauling stone to road	.394
Hauling stone from storage to road..	.254
Loading from storage	.073
Spreading	.074
Rolling and sprinkling.....	.140

Total cost placing stone per cubic yard

\$1.370

The labor cost per square yard of finished macadam was:

	Per Sq. Yd.
Excavation	\$0.030
Shaping	.018
Placing stone	.290
Trimming shoulders.....	.036
Superintendent, watchman and	
water boy	.035
Rolling, supplies, etc.....	.052
Incidentals	.018

Total labor cost per square yard....

\$0.479

(8) *Sullivan Road, Sullivan Township.* The location of the experimental road at Sullivan extends east on the Jonathan creek road for one mile, beginning at the end of a brick pavement at the city limits. The soil is a heavy black loam and very sticky. A part of the work of grading was done by the local commissioners. The stone for the work was furnished by the State from the prison at Menard. The freight on the stone was paid in ballast. The hauling and spreading of the stone was done by contract at 35 cts. per cubic yard and \$3.50 per day for teams which did a part of the grading.

The remainder of the money necessarily for this work was raised by private subscription. Some hauling was donated, but the major part was done by contract. The work was handicapped by bad weather and irregular car service.

The quantities, amount of work and labor cost are as follows:

Length of road	5,800 ft.
Width of macadam.....	12 ft.
Square yards of macadam.....	7,700
Average haul of stone.....	1½ miles
Cubic yards of stone in road.....	3,200
Labor—men, \$1.75 for 10 hours; teams,	
\$3.50 per day.	

Water, 50 cents a tank, 450 gallons.

The cost of the work was:

Excavation	\$ 75.43
Shaping road bed	680.76
Unloading stone from cars.....	306.96
Hauling stone	713.44
Spreading stone	382.70
Rolling, coal, oil, supplies, sprink-	
ling, superintendence, hardware	
and tools	870.09
Trimming shoulders.....	470.29

Total

\$3,499.67

A unit cost of labor placing stone was:

	Per Cu. Yd.
Unloading stone	\$0.096
Hauling stone	.223
Spreading stone	.120
Rolling, sprinkling, supplies, etc....	.150

Total labor cost placing stone....

\$0.589

The labor cost per square yard of finished macadam was:

	Per Sq. Yd.
Excavation	\$0.010
Shaping road bed	.088
Placing stone	.244
Trimming shoulders	.061
Superintendent and watchman.....	.051

Total labor cost per square yard of finished macadam.....

\$0.454

From the data previously given we have compiled the accompanying summaries of the work done. Table I shows the labor cost per cubic yard for placing the stone on the eight roads and Table II shows the labor cost per square yard of the finished macadam in the eight roads. The numerals at the head of each column refer to the roads described previously in this article. It should be remembered that (1) First Street Road De Kalb, was resurfacing work, and that (4), the Lincoln Road, was constructed of shale and stone, hence the incomplete figures for this road in Table I.

The thickness of the first course, measured loose, was 5 ins., and the second course was of a like thickness. The finished macadam varied in thickness from 8 in. to 8½ in. All of the roads were constructed of practically the same thickness except as indicated in the Lincoln road. The binder course is not presumed to have any thickness. The finished thickness of the road varies according to the amount of rolling

received, and sometimes varies on account of the material. The Rock Island road was of full thickness for but 12 ft., and then had shoulders extending on either side for 4 ft., but the center of this road was constructed practically the same as the others. The data given in the report are derived from daily reports received from men in the employ of the State Engineer's office, who are on the work all the time, and is supposed to represent the exact labor cost under the conditions which existed. When superintendence was more than necessary, that is, when the State Engineer's man was employed in addition to the local superintendent, the cost of this man was not included; but the regular cost of doing the work was, so far as the state superintendent was concerned, included.

AN ESTIMATE OF THE COST OF MACADAM ROADS.

In addition to the foregoing data we have also abstracted from the report of the Commission the following matter relative to estimates of the cost of macadam roads.

The data that have been obtained for the cost of work done the past two years furnishes some definite information as to the probable cost of macadam roads. There have been constructed in the past two years, twelve pieces of road, totaling 13.76 miles in length, on which 44,129 cu. yds. of material were used, not including the resurfacing at DeKalb in 1907 and the unfinished work at Highland.

Exclusive of the cost of the material, the total labor expense of preparing the roads, spreading the stone, cutting side drains and, in fact, all work necessary to make the work complete, was \$41,543.44. Table III shows how this amount is apportioned to the various kinds of work as excavation, shaping road bed, unloading stone, etc. The table was compiled from data on twelve experimental roads. Total amount of crushed stone handled was 44,120 cu. yds. It will be noticed that the hauling is by far the largest item of expense, being 34 per cent of the total labor cost. Including unloading, hauling, spreading and rolling, it will be found that the average cost of placing a cubic yard of crushed stone on the road is very close to 60.5 cts. From these figures it will be possible to estimate the average cost of a given road as soon as the quantity of material to be used is determined.

A macadam road that is built 12 ft. wide with two layers of stone spread 5 in. deep, measured loose, will require approximately 2,120 cu. yds., including the amount of material necessary for constructing the blind side drains and furnishing screenings for the binder. At 60.5 cts. a cubic yard, it will therefore cost \$1,282.60 to unload, haul and place this material. It should be stated that the average length of haul is to be not over one mile. If there is added to this sum the average cost per mile of excavation and shaping road bed, trimming shoulders and superintendence—\$369, \$251,

\$162 and \$299, respectively—the estimated total cost per mile is \$2,261.

A cubic yard of limestone is usually reckoned as 2,500 lb. If the material can be obtained f. o. b. cars at destination for \$1.00 a ton, the cost of 1 cu. yd. will therefore be \$1.25 and for the 2,220 cu. yds. required the cost for the material will be \$2,650 and the total cost for the mile of road 12 ft. wide will be \$4,914.

This is due to the fact that these roads are more than 10 ins. thick, and therefore more than 2,120 cu. yds. of material were used in their construction. Although instructions had been given to make 10-in.

enough for traffic to spread out, so that it necessarily would be confined to one track and, therefore, that portion of the road would receive an undue amount of wear and consequently would be more expensive to maintain. It has been a general recommendation to build no roads narrower than twelve feet. As a matter of fact, on all roads so far observed in Illinois, carrying only the ordinary country road traffic, there is no tendency for this traffic to spread over the road, whether it is twelve feet wide or wider. The vehicles invariably keep to the center and use at the most but 8 or 9 ft. of width. Therefore, if a 12-ft. road is to receive the same treatment as

supply of material, it is safe to say that roads cannot be built at any such low figure, and that any plans for extensive mac-

TABLE III.—AVERAGE LABOR COST OF MACADAM CONSTRUCTION.

Work.	Costs.	Per Cent.	Cost of handling 1 cu. yd. stone.
Excavation . . .	\$ 5,079.43	12.4	.....
Shaping road-bed	3,152.50	8.3	.....
Trimming shoulders	2,226.19	5.3	.....
Superintendence, watchman and incidentals . . .	4,113.58	9.9	.....
Unloading stone from car	4,205.25	10.1	9.6
Hauling stone . .	14,128.81	34.0	32.9
Spreading stone .	3,537.15	8.5	8.0
Rolling	4,800.58	11.5	10.9
Total	\$11,543.44	100.0	60.5

TABLE I.—LABOR COST PER CUBIC YARD FOR PLACING STONE ON EIGHT EXPERIMENTAL MACADAM ROADS.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Unloading stone . . .	\$0.050	\$0.175 ²	\$0.065	\$0.138	\$0.086	\$0.159	\$0.135	\$0.096
Hauling stone	.486	....	.316	.474	.633	.179	1.021 ⁴	.223
Spreading stone . . .	.057	.10	.056	.129	.081	.081	.074	.120
Rolling	.154 ¹	.132 ²	.104	....	.096 ³	.146 ³	.140 ³	.150 ⁵
Total	\$0.747	\$0.408	\$0.541	.....	\$0.896	\$0.565	\$1.370	\$0.589

¹Includes rolling, coal, men and sprinkling. ²Unloading and hauling stone. ³Rolling and sprinkling. ⁴This includes: hauling stone to storage, \$0.30; hauling stone to road, \$0.394; hauling stone from storage to road, \$0.254; loading from storage, \$0.073. ⁵Includes rolling, sprinkling, supplies, etc.

roads, the fact that the material was furnished without cost developed a general inclination to be liberal in its use, and, unless a constant watch was kept, those in charge of the work would put on a greater thickness of stone. This thickness, however, is not needed for a serviceable road. When the material is paid for, and more economy exercised in its use, it will be found that the estimate of 2,120 cu. yds. per mile, spread for a width of 12 ft., will give a road of ample thickness.

The estimate here given is on the basis that the haul averages about one mile. It is evident that as construction continues and the haul becomes longer the cost will

it would if it were but a 10-ft. road, there does not seem to be any reason to pay the extra first cost of making the additional 2 ft. in width.

In many cases, however, where an experimental road has been undertaken the general impression is that a 12-ft. road will be too narrow and the people usually desire a wider road. In nearly every instance, after they have used the 12-ft. road they have seen that it is not only wide enough, but that there is a strip of a foot or two on each side which has scarcely been used at all, and that the edge of the road is not cut up by traffic turning out on it so that when plans for extending the work have

adam road building based on an estimate of \$2,000 or \$3,000 a mile must bring in the end only disappointment to all interested.

The U. S. Civil Service Commission, Washington, D. C., will hold an examination on Nov. 25 to secure eligibles from which to make certification to fill three or more vacancies in the position of Office Engineer in Irrigation and Drainage Investigations, Office of Experiment Stations, Department of Agriculture, at salaries ranging from \$1,200 to \$2,000 a year, and vacancies requiring similar qualifications as they may occur in that Department. The duties of this position will be performed chiefly, although not exclusively, at Washington, D. C., and will consist largely of conducting general correspondence, administration of office details, editing technical reports and manuscripts, verifying computations and estimates, making abstracts, and supervising field work. Since the duties of the positions to be filled from the register established through this examination are so varied, a lack of training along any single line mentioned will not bar a competitor if he has sufficiently high qualifications along the other lines.

The U. S. Civil Service Commission, Washington, D. C., will hold an examination on Dec. 9-10, to secure eligibles from which to make certification to fill a vacancy in the position of miscellaneous computer, Naval Observatory, Washington, D. C., and vacancies requiring similar qualifications as they may occur in that observatory. Miscellaneous computers are paid by the hour and earn from \$1,000 to \$1,200 per annum. Promotions are made from this grade, without further examination, to the grade of assistant, at \$1,200 per annum, as vacancies occur.

TABLE II.—LABOR COST PER SQUARE YARD OF FINISHED PAVEMENT ON EIGHT EXPERIMENTAL MACADAM ROADS.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Excavation	\$0.004	\$0.061	\$0.087	\$0.005	\$0.079	\$0.039	\$0.030	\$0.010
Shaping roadbed . . . . .	....	.033	.031	.026	.040	.042	.018	.088
Trimming shoulders	.003	.007	.010	.016	.025	.027	.036	.061
Placing stone	.088	.154	.246	.359	.348	.205	.290	.241
Superintendent	.010 ¹	.040 ²	.036 ³	.029 ⁵	.082 ⁵	.040	.035 ⁶	.051 ¹
Total	\$0.105	\$0.295	\$0.420 ⁴	\$0.445	\$0.574	\$0.353	\$0.479 ⁶	\$0.454

¹Superintendent and watchman. ²Superintendent and incidental. ³Superintendence and watchman. ⁴Includes in addition \$0.010 per sq. yd. for concrete work. ⁵Superintendence, watchman and water boy. ⁶Includes in addition to figures shown in table \$0.052 per sq. yd. for rolling, supplies, etc., and \$0.018 per sq. yd. for incidentals.

be increased; so that if roads 12 ft. wide are to be constructed for a stretch of four or five miles, the average labor cost would not be under \$3,300; and if we estimate the cost of material at \$1.00 a ton, the total cost of the mile would be about \$5,900. In some localities material can be obtained for less than \$1.00, but in many places it would cost more. The cost would, therefore, vary proportionately.

A lower estimate on the average cost would be arrived at by reducing the width of the road, which, on the whole, it is believed would be advisable in many instances. The objection to the narrow road has always been that there is not room

been considered, a ten-foot road has been desired.

The question of actual cost is discussed to show, by figures obtained from actual experience, the cost of this character of work.

Some recent discussions of macadam road construction, which have obtained wide circulation, have, in the minds of many, given the impression that the average cost per mile would not be over \$2,000 or \$3,000. It is perhaps a fact that in a few instances and under special conditions roads have been constructed as cheaply as described; but under average conditions, particularly in localities more or less remote from a

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods and Cost of Constructing a Farm Drainage System.*

(Concluded from page 307, Nov. 1 issue.)

Tile Outlets.—It is essential that where a tile drain outlets into an open ditch, that the outlet end be protected in some manner. As the tile are only a foot in length, the end joint is easily washed out or is soon destroyed by scaling when exposed to air and frost. It is often tramped out or crushed by stock watering in the main ditch. As soon as the end pipe is destroyed, the next one above is subject to the same destructive influences, thus interfering with the outlet and often preventing the proper discharge, and may cause sediment to settle; hence, it is necessary to protect the outlet in some manner other than laying a tile into the open ditch. Such protection is usually spoken of as a tile outlet. Nearly all works on drainage, in speaking on this subject recommend the use of a stone abutment, but in many sections where tiling is extensively carried on, stone are not available except as they are shipped in, such an outlet becoming so expensive that it is seldom used. The common practice has been to use a wooden box, the outer end of this box being covered with a wire screen to prevent the entrance of small animals. Such an outlet is very satisfactory, but the high price and poor quality of lumber at the present time make such an outlet expensive for the length of time it lasts. Hence, it has been thought advisable to try a number of different methods for protecting the outlet tile. A description of each, with the bill of material and cost of constructing one of each of these outlets is given.

Wood Box.—The wood box outlet, during its life, serves the purpose in a satisfactory manner, but it requires frequent renewals. It is heavy to handle and requires considerable extra digging to fit it to the end of the tile. Where the box is not of sufficient size for the last tile to enter the end, the lower side should extend a couple of inches beyond the other three sides. This will permit of the end tile resting on the lower side and a good junction between the tile and box can be secured. If the box is made as shown in Fig. 4 (A), less lumber is required to make a box that will conform to the tile than if made as shown in Fig. 4 (B).

MATERIAL AND COST OF MAKING A BOX FOR 4 AND 5 IN. TILE.

4 2"x8"x12' rough pine, 64 ft. at \$27. \$17.4

8 ft. 12-gage wire, for screen, at 6c per lb. 02
18 Wire staple at 1c per lb. 01
20 20-pd. spikes at 4c per lb. 03
Labor of making box, half hour, at 20c per hour 10
Labor of placing box in ditch, 40 min. at 20c per hour. 13

Total\$2.03

MATERIAL AND COST OF MAKING 12. FT. BOX FOR 8 IN. TILE.

4 2"x12"x12' rough pine, 96 ft. at \$32\$3.07
12 ft. 12-gage wire, for screen, at 6c per lb. 03
22 Wire staples at 4c per lb. 013
32 20-pd. spikes at 4c per lb. 05
Labor of making, half hour at 20c per hour .. .10
Labor of placing in ditch, one hour at 20c per hour. 20

Total\$3.46

Culvert Metal Pipes.—This material is the same as used in the making of corra-

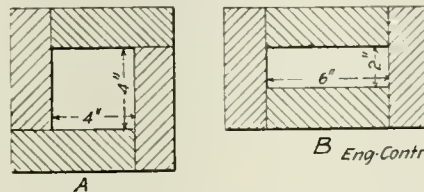


Fig. 4—Forms of Wood Box Tile Outlets.

gated metal culverts, except that the metal was not corrugated. The pipe was made of 14 gage metal, 6 ins. in diameter, 10 ft. long and weighed 45 lbs. riveted together. The wire screen was made by weaving the wire through holes drilled in the metal 1 in. from the end. This form of an outlet is easily trenched, requires no more time to place in trench than the laying of the same length of tile, and apparently is heavy enough to stand the tramping of animals without injury and it is thought will be lasting, but is most too expensive for general use in farm drains of small size. For large sizes of tile its use would be much more economical.

MATERIAL AND COST FOR 4 OR 5 IN. DRAIN.

1 Culvert metal pipe, 6" diam., 10' long\$7.50
8 ft. 12-gage wire for screen at 6c per lb. 02
Labor of drilling and putting on screen, half hour at 20c. 10

Total\$7.62

Galvanized Iron Pipe.—This outlet was made of 20 gage galvanized iron, 6 ins. in diam., 10 ft. long, riveted together and weighed 30 lbs. It has the same advan-

tages as the culvert metal outlet, but its lasting qualities are questionable and it is doubtful if it will be stiff enough to prevent crushing by stock. However, the ease with which it can be procured merits a trial.

MATERIAL AND COST FOR 4 OR 5 IN. DRAIN.

6" galvanized iron pipe, 10' long.....\$3.50
8 ft. 12-gage wire, for screen, at 6c per lb. 02
Labor of drilling and putting in screen, half hour at 20c. 10

Total\$3.62

Sewer Pipe.—As sewer pipe of various diameters are readily purchased in nearly all localities, very good outlets can be made of this material. It is not affected by the freezing and has sufficient strength to prevent stock breaking it. While it comes in 2 ft. length, the nature of the joint is such that if it is properly laid, it is nearly as strong as a continuous pipe, but it is rather difficult to attach the screen as it is not easily drilled. This can be more readily done on the bell end by nicking the edges of the bell with a cold chisel. Notches deep enough to hold the wires can be made and they can be fastened by winding around the pipe back of the bell. To lay the pipe properly, holes should be dug for the bells and the joints thoroughly cemented. This is rather difficult in a deep tile trench unless considerable extra digging is done. As 5-in. sewer pipe was not available, a joint of 6-in. pipe was used on the end.

MATERIAL AND COST FOR 4 IN. DRAIN.

1 joint 2' in length, 6" sewer pipe, at 17c per ft.\$0.34
4 joints 2' in length, 4" sewer pipe. at 14c per ft. 1.12
12 ft. 12-gage wire, for screen, at 6c per lb. 03
0.1 sack of cement, at 75c per sack... .075
0.3 cu. ft. of sand at \$1.50 per cu. yd. .016
Labor, 2 men, 1 hour each, at 20c per hour 40

Total\$1.98

Cement Tile.— This outlet was constructed by using the ordinary cement drain tile. The ends were cemented together by a band of cement running entirely around the tile and extending back about 2 ins. on to each tile. The screens were put in the same as on the clay tile. This outlet has nothing special in its favor, except the using of material that is at hand.

MATERIAL AND COST FOR 4 IN. DRAIN.

3 5" cement tile at \$0.42 each.....\$0.13
7 4" cement tile at \$0.031 each..... 0.22
8 ft. 12-gage wire, for screen, 6c per lb. 0.02
0.2 sacks of cement at 75c per sack... 0.15
0.5 cu. ft. of sand at \$1.50 per cu. yd.. 0.02
Labor of drilling pipe and making screen, half hour at 20c per hour... 0.10
Labor of placing in trench, 2 men half hour at 20c per hour. 0.10

Total\$0.84

*Abstract of a Report on the Installation of an Experimental Drainage System at the Northwest Experiment Farm, University of Minnesota, Crookston, Minn. Bulletin No. 110.

Tile Enclosed in Cement.—This outlet was made in an attempt to secure an outlet that would meet all the requirements at a small cost. The last 10 ft. of the tile were encased in a coating of cement approximately one inch in thickness. At the end tile the cement on the top and sides was increased to two inches in thickness. The cement protects the tile from the freezing and strengthens it in case of tramping, and practically makes a continuous pipe of the last ten feet. The only extra excavating done was to increase the depth of the trench one inch with the tile scoop to allow for the coating of cement under the tile with a hand-fed post drill, and putting in wire the same as in the metal pipes.

MATERIAL AND COST FOR A 4 IN. DRAIN.

The screen was made by drilling the end tile. The three end tile were an inch larger in diameter than the main drain. 3 5" drain tile at \$0.0372 each.....\$0.1116
7 4" drain tile at \$0.264 each..... 0.1848
1 cu. ft. of sand at \$1.50 per cu. yd. 0.055
1.5 cu. ft. cement at \$0.75 per cu. ft. 0.15
8 ft. 12-gage wire, for screen, \$0.06
per lb..... 0.02
Labor of drilling tile and putting in screen, half hour at 20c per hour. 0.10
Labor of constructing at trench, 2 men 1¼ hrs. each, at 20c per hour 0.50

Total\$1.12

Concrete Abutment.—In this outlet the tile were laid the same as in the one above described, with the exception that only the three end tile were encased in cement. A small concrete abutment was then put in on top of these tiles. This abutment completely filled the trench to a height of about 18 ins., the outer surface having the slope of the open ditch side. The abutment will protect the tile from all injury and tend to prevent the loose dirt from running down into the open ditch; does not require any extra work in a deep trench; is quickly constructed and requires no special skill. The concrete was made of 1 part of cement, 4 parts sand, and 4 parts broken tile. A small amount of a mixture of 1 cement to 5 of sand was used around the end tile and for smoothing down the surface of the abutment.

MATERIAL AND COST FOR 4 IN. DRAIN.

3 5" drain tile at \$0.0372 each.....\$0.1116
7 4" drain tile at \$0.264 each..... .1848
½ cu. ft. cement at \$0.75 per sack. .375
2 cu. ft. sand at \$1.50 per cu. yd.... .11
2 cu. ft. broken tile at \$0.02 per cu. ft..... .04
8 ft. 12-gage wire for screen at \$0.06 per lb..... .02
Labor of drilling tile and putting in screen, half hour at 20c..... .10
Labor of placing in trench, 2 men half hour at 20c..... .20

Total\$1.14

At one of the concrete abutments the earth was tamped back into the ditch and

then covered with 1 in. of concrete, the width of the trench from the top of the abutment to the top of the open ditch slope. On this was spread a piece of woven wire fencing 14 ins. wide and 36 ins. long. Another inch of concrete was placed on top of the wire. The concrete, strengthened by the wire, protects the outlet from the freshly filled drain.

THE ADDITIONAL COST OF THIS WORK.

0.1 cu. yds. cement.....\$0.75
0.5 cu. yds. sand..... .027
Woven wire fencing, 14"x36"..... .030
Labor, half hour at 20c per hour.... .10
Cost of cement abutment from above. 1.14

Total\$1.37

As the screen on an outlet offers some obstruction to the flow of water, the outlet should be increased in size at least 1 in. larger than the drain before the screen is reached. In placing pipes or boxes they should be carefully tamped in and a good junction made with the tile. Where practical, the last tile should extend 2 ins. into the outlet. If the water begins running around the outside of the outlet, it is liable to wash out. There should be no difficulty experienced from this source with any of the outlets in which cement is used. Until the trenches have thoroughly settled and the slope of the ditch has set in grass, the loose dirt will slip down in front and leaves will blow through the screen and when the water begins to run, this drift will wash down and lodge against the screen, causing an obstruction. The outlets will thus require some attention to keep them in working order for a year or two after construction.

Back Filling Tile Trenches.—The re-filling of tile trenches is accomplished in several ways. Short sections in the vicinity of fences or buildings, are filled by hand, the tools used being a shovel or ordinary spade. Where the material is soggy or sticky, a potato or heavy tined fork can be used to advantage. Coarse sod can be conveniently handled by a fork bent in the form of a hook. Where a team can be used, short sections can best be filled by two men with team and slip scraper. The team works at right angles to the trench and is attached to the scraper by a rope or chain about 10 ft. in length; the scraper holder sets the slip under the spoil bank, the team is driven ahead, the material being dumped just as the trench is reached, when the team is stopped and backed up, the scraper being pulled backward by hand for a new load. Where there is a line of trench free from obstructions, the most economical method of filling is by using a plow. For rapid work three men and two teams are used. The team is attached to the plow by an evener made of pine 3x8 ins.x8 ft., a number of holes being bored 6 ins. apart for the plow clevis. The teams are driven either side of the spoil bank and ditch. The plow is moved back and forth on the evener to the required position, which throws more of

the load on one team than on the other, but as it will be reversed on the return trip, this is not of material importance. The plowing is done up one side and down the other, regardless of the position of the spoil bank, two rounds usually being sufficient on each ditch. A reversible road grader is then used. This requires two teams and three men. Four rounds level off the spoil banks in good shape except in trenches which are 5 ft. in depth, where an extra round is required. A road drag can be used for leveling, but it is difficult to control, and is not quite so speedy as the grader. Cultivated land is easier to fill and requires less leveling than sod. As horses are usually afraid of a ditch, it is necessary to have a driver with each team. Slow, steady teams are the best, as both plow and grader run heavy and any jerking is liable to cause breaks. Trenches with the dirt on both sides are more easily levelled off than those with the dirt all on one side. Before the plow is used, it is necessary to fill a section at the outlet end by scraper or hand, on which teams can be turned. Where the outlet is an open ditch, with steep slopes and fresh spoil banks, it is best to fill a short section by hand, then use a scraper till the spoil banks are cleared sufficiently to permit the plow and team to turn. This prevents the throwing of loose dirt into the open ditch and the catching of the plow and grader in the spoil bank.

COST OF FILLING 100 FT. OF TRENCH BY HAND.

Trench 4.5 ft. deep, 3.75 hrs. at 20c per hr.\$ 0.75
Trench 3.0 ft. deep, 2.8 hrs. at 20c per hr. 56
Trench 2.0 ft. deep, 2.0 hrs. at 20c per hr. 40

Total\$1.71

COST OF FILLING 100 FT. OF TRENCH BY

SLIP SCRAPER.

Trench 3.5 ft. deep, team with driver
55 min. at 45c per hr.....\$0.4125
Scraper holder, 55 min. at 20c per hr. .1833

Total\$0.60

An increase or decrease of 1 ft. in depth would have little effect on the cost of this work.

COST OF FILLING 100 FT. OF TRENCH WITH PLOW AND GRADER.

Plows:

2 teams with drivers on plow, 6 min.
each, at 45c per hour.....\$0.090
1 man to hold plow, 6 min. at 20c per hour 0.020

Total\$0.110

Grader:

2 teams with drivers on grader, 10 min. each at 45c per hour.....\$0.150
1 man operating grader, 10 min., at 20c per hour 0.033

Incidentals: Wear and tear of machinery 0.027

Total\$0.320

The cost of plow and grader work is the average of all the ditches filled in this manner. They varied in depth from 2.5 ft. to 5 ft., with an average of 3.5 ft.

Observation Wells.—For the purpose of keeping a record of the ground water in

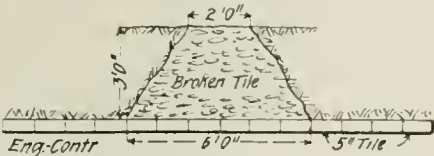


Fig. 5—Catchbasin of Broken Tile.

fields that are tiled and those that are surface drained, a number of wells were located, it being the intention, at frequent intervals during the wet season, to measure the depth of water below the surface at these points. In this manner the action of the tile can be studied. For convenience,

being displaced, the number being stamped on the inside of the cover with a steel die. The wells are put down by a post digger after the trenches have been filled. In setting the tile wells, it is necessary to have a round pole which will just fit the inside. This keeps the tile in line while they are being tamped.

MATERIAL AND COSTS.

Tile well, 4 ft. deep:	
4 4-in. tile at \$0.0261 each.....	\$0.1056
Lumber for cover, 1.25 ft. at \$28....	.0350
1 20-pd. spike at \$0.04 per lb.....	.0016
Labor of making cover, 3 min., at \$0.20 per hour	.0100
Labor of constructing well, 40 min., at \$0.20 per hour	.1333
Incidentals, hauling lumber, distributing covers, etc.....	.0145
Total	\$0.3000

COST PER 100 FT. FOR TRENCHING, LAYING TILE AND BLINDING.						
Depth.	Size of Tile.					
	4, 5, 6 in.	7 in.	8 in.	9 in.	10 in.	12 in.
3.0 ft.....	\$2.42	\$2.79	\$3.15	\$3.51	\$3.88	\$4.24
3.5 ft.....	2.79	3.15	3.51	3.88	4.24	4.61
4.0 ft.....	3.15	3.51	3.88	4.24	4.61	4.97
4.5 ft.....	3.88	4.24	4.61	4.97	5.33	5.70
5.0 ft.....	4.61	4.97	5.33	5.70	6.06	6.43
Cost of refilling trench.....	\$0.32 per 100 ft.					
Incidentals	\$0.20 per 100 ft.					

in recording they are numbered in the order in which they are to be examined. These wells are 4 ft. in depth, with the exception of 14, which are only 3 ft. deep, the intention being to have them down to or below the bottom of the drain. The

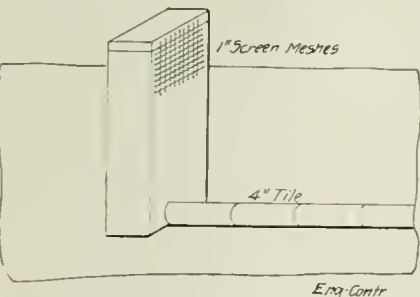


Fig. 6—Wood Box Catch Basin.

top is flush with the ground surface. Except six, the wells are all constructed of 4-in. tile of the same make as the drains in their immediate vicinity. For comparison, six wells were constructed of 1x4 in. x 4 ft. pine lumber, so put together as to form a

Tile well, 3 ft. deep cost		\$0.2400
Lumber well, 3 ft. deep:		
1 piece 1 in. x 4 in. x 16 ft. rough pine lumber, 5.33 ft., at \$40.....		.2133
16 8-pd. nails at 4 c per lb.....		.0080
Labor of making, 10 min., at 20c per hour		.0333
Cost of cover and construction, same as above		.1799
Total		\$0.4345

House and Yard Drainage.—In draining around buildings and barnyards where the ground is tramped, the soil is often puddled in such a manner that water will not filter down, and under-drainage is not effective unless there are surface openings to facilitate the inlet of water. For the purpose of improving the drainage around the buildings, a number of surface openings or catch basins were made. In the road gutters and in low places where surface water is liable to collect, broken tile were used as catch basins (Fig. 5). Before refilling, the trench was filled the entire

the tile through the joints as rapidly as it collects. This class of catch basins answers the purpose well for a time, but they are liable to become clogged by material washing into them. However, they are inexpensive and made of condemned tile which are otherwise useless. The cost of the ones put in was 10 cts. each.

Another class of catch basin as shown in Fig. 6 was put in for the purpose of carrying the roof water down to the tile.

COST OF WOOD BOX CATCHBASIN.

3 pieces pine lumber 2x8x36 ins.,	
1 piece pine lumber 2x8x18 ins.,	
1 piece pine lumber 2x8x12 ins.,	

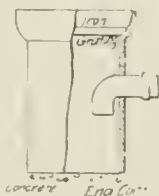


Fig. 7—Tile Catch Basin.

7.3 ft., at \$32.....	\$0.23
16 ft. of No. 12 wire, at \$0.06 per lb..	.04
30 wire staples at \$0.01 per lb.....	.02
18 20-lb. spikes at \$0.04 per lb.....	.03
Labor of making box, 1 hour at \$0.20 per hour	.20
Labor of setting, half hour at \$0.20 per hour	.10
Total	\$0.62

At three points, where a large amount of surface water will collect, a more substantial form of catch basin (Fig. 7) was put in. One of these basins consisted of one 30-in. joint of 18-in. sewer pipe, being

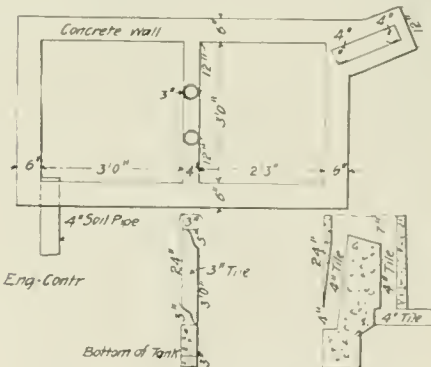


Fig. 8—Concrete Septic Tank.

set in the ground so that the top of the bell was slightly below the surface. The earth at the lower end of the pipe was covered with 2 ins. of concrete; 14 ins. below the top a hole was cut and a 4-in. 90° outside and connected with the drain by tile. Concrete was filled around the bend and also around the top of the large pipe. This was done to prevent its being tramped out of place by stock in the wet season. The large pipe was covered by an iron grating placed inside the bell. The water will flow into the basin through the grating, the heavy material settling to the bottom and the light material floating. The

COST OF HAULING AND DISTRIBUTING TILE PER 100 FT.		
Based on 80 cts. per ton for the first mile, which includes loading and unloading and 30 cts. per ton for each additional mile.		
4 inch.....	\$0.26 for 1 mile haul	\$0.10 for each additional mile.
5 inch.....	.36	.13
6 inch.....	.48	.18
7 inch.....	.56	.21
8 inch.....	.72	.27
9 inch.....	.84	.31
10 inch.....	1.00	.37
12 inch.....	1.32	.49

box 3 ins. square on the inside. A cover is made by a block of wood 2x6x6 ins. To the center of this cover there is fastened by a 20 pd. spike, a block of wood 3x3x6 ins. This latter block fits inside the top of the well and prevents the cover from

width with broken tile for 6 ft. at the bottom and drawn in at the ends until it was 2 ft. long at the surface of the depression. The broken tile served to let the water down to the drain and distributed it along a sufficient distance so that it can enter

water, being taken out of the basin between the bottom and the surface, will not carry any material into the drain which would interfere with its working.

COST OF THE CATCHBASIN.

1 joint 30 in. sewer pipe, 18 in. in diameter	\$2.25
1 90-degree bend sewer pipe, 4 in. in diameter	.50
1 cast iron grating, 18 in. in diameter ..	3.20
2 cu. ft. of concrete at 20c.....	.40
Labor of digging, 1 hour at 20c.....	.20
Labor of cutting hole in 18 in. sewer pipe, 2 hours at 20c.....	.40
Labor of setting basin, 2 hours at 20c.....	.40
Incidentals	.25
Total	\$7.60

separates the second chamber, which is the same size as the first with the exception that its length is 4 ins. shorter. The sewage enters the second chamber by means of two 3-in. tile set vertically in the partition, the side of the tile being cut away 9 ins. above the bottom of the tank, to permit the entrance of the sewage, while the side is cut away in the opposite chamber 3 ins. below the water line for its egress into the second chamber. The outlet is at the corner of the second chamber opposite the inlet. The outlet is made by means of a 4-in. tile set in an incline through the end wall and is so arranged that it will take the water a foot above the floor of the tank and discharge it when the water in the tank stands $\frac{1}{2}$ in. below the bottom of the

4 3 in. tile at 2.5c.....	0.10
5 4 in tile at 2.8c.....	0.14

Total\$18.65

No charge is made for sheathing lumber, as this was bought for another purpose and was not injured in making the form to hold the concrete in place till it set. Lumber was used for a covering, as it is desired to have the tank in such a condition that it can be entirely opened up and its workings examined, the filling over the tank being made with horse manure so that it can be quickly removed.

Conclusion.—Except where otherwise specified, all the labor of installing the system was done by ordinary farm help at a rate per day of \$2 for men and \$2.50 for team. None of this help had any experience in drainage work, and owing to the fact that the men frequently changed, it was necessary to be continually training inexperienced men.

Under present conditions, the cost of the various items of under-drainage would be, approximately, as follows, based on the prices paid at the farm:

COST OF TILE PER 100 FT. AT NEAREST RAILWAY STATION.

4 inch.....\$2.52	8 inch.....\$ 7.25
5 inch..... 3.41	9 inch..... 9.90
6 inch..... 4.50	10 inch..... 11.75
7 inch..... 5.64	12 inch..... 14.60

The plan of that portion of the city of Valparaiso, Chile, that was so badly wrecked by the earthquake of Aug. 16, 1906, has been about completed by the authorities. Many of the streets have been widened and straightened and new streets opened at great expense. Much of that part of the city is to be raised from 2 to 4 ft. and many of the sewers rebuilt. These improvements will add much to the appearance and desirability of the city and will cost about \$10,000,000.

The Board of Water Supply of New York City is now calling for bids for constructing the Wallkill pressure tunnel in connection with the project for securing an additional water supply for the city. The work on which bids are being asked is as follows: Contract 36 for the construction of the north half of the Wallkill pressure tunnel, a tunnel in rock crossing under the valley of the Wallkill river, with three shafts 350 to 480 ft. in depth, and a short stretch of plain concrete conduit, known as cut-and-cover aqueduct; and Contract 37 for the construction of the south half of the Wallkill pressure tunnel, with three shafts 350 to 400 ft. in depth, and a short stretch of plain concrete conduit, known as cut-and-cover aqueduct. The pressure tunnel will be circular, 14½ ft. inside diameter, and the aqueduct, 17 ft. high by 17½ ft. wide inside. The work is located in the towns of New Paltz and Gardiner, Ulster county, New York.

GENERAL SUMMARY OF DRAINAGE WORK.

Drain.	Length in ft. of each size.					Length of ditch.	Max. cut.	Min. cut.	Average cut.	Grade per 100 ft.	Cost of trenching, laying and blinding per 100 ft.	Method of digging.
	8 in.	6 in.	5 in.	4 in.	3 in.							
No. 1.....	800	100	900	4.06	3.28	3.15	0.4-0.8	42	Spade			
No. 2.....	210	505	715	3.37	3.31	2.91	0.4-0.2	42	Spade			
Branch* 1.....	323	325	6.03	3.02	4.01	0.2	42	Spade				
No. 3.....	1325	1325	5.57	2.81	3.68	0.1	91	Spade.				
No. 4.....	409	211	629	4.88	2.49	3.33	0.1	67	Mach.			
No. 5.....	404	216	620	5.05	2.70	3.51	0.1	79	Mach.			
No. 6.....	1325	1325	5.69	2.40	3.57	0.1	84	Spade-400-mach.				
No. 7.....	420	200	620	5.13	4.03	3.48	0.1	77	Mach.			
No. 8.....	400	220	620	5.43	2.45	3.60	0.1	85	Mach.			
No. 9.....	460	160	620	5.56	2.55	3.72	0.1	95	Mach.			
No. 10.....	1325	1325	5.39	2.56	3.57	0.1	84	Spade-400-mach.				
No. 11.....	600	600	4.05	3.18	3.20	0.1	42	Spade				
No. 12.....	720	720	3.00	1.63	2.49	0.1	42	Spade				
No. 13*.....	590	85	675	4.37	2.72	3.52	0.2	42	Spade			
No. 14.....	590	590	3.57	2.40	2.99	0.2	42	Spade				
No. 15.....	650	650	3.71	2.11	2.84	0.2	42	Spade				
No. 16.....	1375	1375	3.55	2.46	2.91	0.1	42	Mach.				
No. 17.....	590	590	3.58	2.34	2.98	0.2	42	Spade				
No. 18.....	895	280	1175	4.02	1.74	2.80	0.1	42	Spade			
Branch 1.....	210	210	3.06	2.01	2.30	0.1	42	Spade				
Branch 2.....	220	220	2.74	1.93	2.38	0.1	42	Spade				
Branch 3.....	430	430	2.89	1.62	2.18	0.1	42	Spade				
Branch 4.....	300	300	2.33	1.71	2.00	0.1	42	Spade				
No. 19.....	1375	1375	3.84	2.32	3.06	0.1	42	Mach.				
No. 20.....	1175	1175	3.65	1.37	2.69	0.1	42	Spade				
No. 21.....	1375	1375	3.68	2.08	3.07	0.1	48	Mach.				
No. 22.....	1175	1175	4.24	1.48	2.92	0.1	42	Mach.				
No. 23.....	1175	1175	3.30	1.96	2.93	0.1	42	Mach.				
No. 24.....	1175	1175	3.99	2.92	3.65	0.1	90	Mach.				
No. 25.....	1375	1375	3.40	2.34	2.88	0.1	42	Mach.				
Main A.....	747	23	770	3.95	2.10	3.55	0.05	82	Mach.			
No. 26.....	600	1665	395	4.02	2.40	3.12	0.05	51	Mach.			
No. 27.....	600	1600	2660	3.82	2.11	3.10	0.05	50	Mach.			
No. 28.....	600	1600	2660	4.01	2.45	3.27	0.05	62	Mach.			
No. 29.....	1315	425	1740	3.99	2.91	3.60	0.07	86	Mach.			
No. 30.....	1337	398	1735	4.14	2.97	3.52	0.07	80	Mach.			
No. 31.....	1410	315	1725	4.09	2.59	3.39	0.07	71	Mach.			
No. 32.....	1185	543	1728	3.89	2.41	3.21	0.07	58	Mach.			
No. 33.....	1323	402	1725	3.50	2.42	3.01	0.07	42	Mach.			
No. 34.....	1320	400	1720	3.53	2.11	2.71	0.07	42	Mach.			
No. 35.....	245	155	400	3.94	2.59	3.19	0.07	56	Mach.			

*2.—Note.—A short section dug on each section with machine.

The cost of construction of this basin is made on the assumption that the tile drain had already been laid up to the point at which it is to be located.

As it was desired to fit up the new house being built for a superintendent's residence with modern plumbing, it was necessary to arrange some method of sewage disposal. A small septic tank, Fig. 8, has been constructed of concrete, 1 part cement to 7 parts sand and gravel, the walls being 6 ins. and the floor 3 ins. thick. This tank consists of two chambers. The soil pipe from the building entering at the upper corner of the first chamber, which is 3 ft. in all dimensions. A 4-in. concrete wall

soil pipe. The waste being discharged into a vertical tile, which leads it down to a 4-in. tile drain outleting in the drain No. 1. The top of the tank is covered with 2-in. plank and will be buried 2 ft. below the ground surface. Air will be admitted near the outlet through a 2-in. opening.

MATERIAL AND COST.

Labor of digging pit, 10 hours at 20c.....	\$ 2.00
2 cu. yds. gravel at \$1.50 per cu. yd.....	3.00
7.5 sacks cement at 75c each.....	5.62
Labor of concreting, 30 hours at 20c per hour	6.00
4 pieces pine lumber, 2 in. x 12 in. x 7 ft., for cover, 56 ft. at \$32.....	1.79

LETTERS TO THE EDITORS.

A Criticism of the Competitive Contract System.

Sirs:—I have been a constant and appreciative reader of "Engineering Contracting" from the time of its first issue, recognizing that it is unique in its particular field. Certainly the contracting fraternity should have a publication devoted to its interests and you are supplying one in a very admirable manner. I am sorry, therefore, to be obliged to take issue with you upon some of the general principles you have laid down and continue to advocate. Kindly grant me a little space to enlarge upon this, as I am convinced that your ardor in advancing the interests of contractors in general has unconsciously influenced you in advocating present erroneous methods of construction.

The position that you adopted in regard to the letting of contracts on the Panama Canal is a case in point and serves to illustrate my meaning. You believe and you advocate that all public work should be constructed by the method of competitive proposals, notwithstanding that the present method of competitive construction has been recognized for many years among the better class of contractors as being the most pernicious system that could be inaugurated. No progress in civilization can be made under any system which fosters the worst traits of human character. The reverse should be the case, for real and lasting progress can only be made by the cultivation of man's best qualities, and any system which does not produce this result is wrong in principle and becomes corrupt in practice.

There are three interests mutually concerned in the development of all engineering problems. The first interest is the capitalist or owner, the man whose money pays for the work.

The second is the engineer whom the owner employs to design his work and carry it forward to completion. It is very seldom that a good engineer has either the time or the inclination to perfect himself in executive management. His mind must be trained technically, and to be a good engineer he must have the faculty which enables him to solve natural or physical problems. Therefore, the executive department of the construction—the dealing with common labor and its management—devolves upon a third party, the contractor, who may or may not have an engineering education. The contractor, if he has a proper training, has developed a faculty for the management of men, which is a problem entirely apart from the scientific and technical problems with which the engineer concerns himself. We might call one faculty the engineering instinct, the other the construction instinct and illustrate them as follows:

The first thing that an engineer observes or should observe when he goes upon a

piece of work is whether his lines and grades are being carried out and whether the quality of the work is satisfactory. His training should instinctively force him in this direction. On the other hand, when a contractor goes upon a piece of work the first thing he observes is whether every laborer is busy, and secondly whether every laborer has his shovel full and the work proceeding harmoniously and rapidly. His training has taught him this.

It is very seldom that these two different faculties are present in the same mind; hence the necessity for both the engineer and the contractor. How obvious that these two should work *together* and in harmony at all times. Unfortunately under the present system this is very rarely the case. The contractor nine times out of ten bases his proposal, not so much upon the actual cost of the work with a proper profit added, but more upon the competition which he foresees. He is therefore all of the time taking chances, minimizing the contingent expenses and frequently trusting to luck. Too often in his study of the specifications he finds loop holes which he thinks will enable him to bring in extra bills, which extras are counted upon as another source of profit.

Both the engineer and the owner know all this, and they endeavor to forestall over-charges, poor quality of work, etc., by elaborate plans and rigid specifications. The usual specification gives the contractor no rights whatever excepting such as the engineer may good naturedly permit, and this good nature, or the lack of it, is again a factor in the contractor's mind, largely influencing his proposal. The first question that a contractor asks himself is: What kind of an engineer have I got to work under?

We start, therefore, with a mutual antagonism, the contractor endeavoring to get all he can out of the work and the engineer endeavoring to prevent him from so doing. I am not speaking in this connection of contractors who deliberately take a piece of work, expecting to skimp its quality and make their profit in that way; neither am I speaking of those engineers who have no mercy whatever for the contractor, and force everything to the lowest possible cost, without regard to right or justice. I am not taking individual cases, nor extreme methods, but am speaking only of the *system* as it exists.

Under this system the owner, who generally knows nothing about construction, and relies entirely upon his engineer, has two sources of anxiety. If the contractor and the engineer get along too well together he is suspicious that his pocket may suffer. But if the engineer and the contractor do not conceal the antagonism which has been forced upon them both, then the owner is in trouble all the time. Consequently these three interests, which manifestly should work in harmony and with full co-operation all the time, are by

the very force of artificial conditions obliged to be antagonists upon a piece of work which should receive the best energy of each.

Because of this in very many instances the work itself suffers; because of this in the majority of instances contractors do not make money; and because of this the word "contractor" has become synonymous with "rogue" and "rascal." I protest that this is not fair. It is not just to the large body of contractors, men of education and experience, men of a high sense of commercial and constructive honor, men who are devoting the best energies of brain and body to the development of this country in the frontier of progress. Why should these men, as a class, be so branded? Why should specifications in general be so worded that they proclaim upon their face that the contractor is not worthy of trust? It is because of the *system*. It is because modern competitive contracting has brought to the surface the worst traits of human nature. When men have become tired of the mutual antagonism thus artificially developed, and are sufficiently educated along different lines, then the whole system must be and certainly will be changed.

For that reason I do not like to see a publication of the high class and character of "Engineering Contracting" advocating methods which will, or at least which should, presently fall into disuse. There is already a spirit growing in the minds alike of owners, engineers and contractors that better results can be produced in other ways. They do not believe that the boasted American spirit of "fair play" will continue a system which allows men to enter into business relations based upon a mutual distrust established by the very terms of these relations.

An endeavor therefore has been made to bring the owner, the engineer and the contractor into co-operative relations, where each is acquainted with every detail of the work; where the costs of the work are known daily and in detail to all concerned; where the owner has daily and definite knowledge regarding the progress of his work; where the best qualities of the engineer are assisted by the best qualities of the contractor; where no extraordinary expenses are created without consultation; where the engineer receives proper payment for his services, and this payment is known before the work begins; where the contractor is put upon exactly the same basis, receiving proper compensation for his services and no more, and placed in a position where he assumes only such risks as pertain to his department and not those which justly belong to the owner or the engineer; and, more than all, where the contractor and engineer may sit down *together* and estimate the cost of the work undisturbed by the influence of competition. They should figure *together* what the work is going to cost and discuss *together* the various contingencies which may arise, the possibilities of extra work included. The

owner receives in advance of construction, the benefit of two trained minds studying the same problem from different points of view, and ascertains what his work is going to cost with a far greater degree of accuracy than under the competitive method.

After all estimates are made and the compensation of the engineer and of the contractor determined upon, what then is the *motive* which inspires both of these men in their different departments? There can be no motive for the making of more money, as that has already been decided. The engineer cannot gain reputation by forcing the contractor to produce results in excess of the specifications; and the contractor can gain nothing by doing poor work. The only motive then which can influence both of these men is to produce the best possible piece of work within the shortest space of time and at the lowest cost. The contractor's reputation is enhanced by producing good work at low cost. He wishes to do it as rapidly as possible so that he may relieve his construction plant and superintendents and use them on other work. He knows that if he does a good job, satisfactory to the owner, he stands a better chance of getting more work of the same character.

The motives which influence the engineer are the same. Therefore there is mutual harmony of thought, feeling and action in all the departments of finance, design and construction, and this alone produces the best results.

This method also brings forward a better class of constructors, because men who do poor work or who have not the ability, training or experience to produce good work, cannot get the work to do. They may make two or three attempts but their reputation will follow them like an open book for all to read who are interested. It is a fact that this method of contracting is growing in popular favor. It should be so. It is a step in advance.

The writer has had an experience of thirty years in public works construction. He has, during all of this time, chafed under the system of competitive contracting knowing that this method, too long pursued, produces bad results, not only in personal character, but in the work itself. He has tried the unit price method, the lump sum method, and the monthly percentage method, all of which are in the same category: wrong in principle, selfishly base in motive and generally unsatisfactory in results. For the past four years he has been engaged in the construction of a specialty upon which no work is undertaken excepting upon a fixed commission basis. During these four years what has been the result to the *owners* of the structures which have been built?

During that time this company has built 41 dams, every one of which has been a complete engineering success.

Seven of these dams were built in the first year of business. They were satisfac-

tory to the owners and were valuable as an experience in construction, but not as affording accurate cost data.

On six dams, although no preliminary estimate was requested, the cost was entirely satisfactory to the owner.

On one the costs of the dam were kept by the owner in connection with other construction work and he did not care to separate them.

On five the plans were radically changed at the owner's request, making the preliminary estimates of no value.

Two dams are now in process of construction, neither of which will exceed the estimate.

Two dams exceeded the estimate in cost and eighteen were built below the estimate, the saving varying all the way from 1½ per cent to 12½ per cent. The owners invariably are better pleased with this method of contracting as soon as they become acquainted with it and delighted to find that there is a method of construction which returns to the owner some part of his appropriation.

I submit to you in the light of this experience whether you would not be wise in endeavoring in your publication to eradicate so far as it lies within your power the mutual distrust and suspicion which usually obtains to-day under the present destructive and pernicious system of competitive contracting.

Yours very truly,

C. H. Eglee, General Manager.

Ambursen Hydraulic Construction Co.,
Engineer-Constructors, 176 Federal St.,
Boston. Oct. 29, 1908.

[Comment upon this interesting letter will be found in our editorial columns.—Editors.]

Cost of Erecting Truss Bridges.

In a report of a Committee of the Association of Railway Superintendents of Bridges and Buildings some data are given as to the cost of erecting bridges on the Atchison, Topeka & Santa Fe Ry. The average cost per ton of the bridges erected in 1907, all of which were on the main line of this railway, and consequently made it necessary to contend with all trains was as follows:

	Per Ton.
Trusses, 984 tons erected.....	\$4.63
Girders, 2,784 tons erected.....	5.19
I-beams, 2,837 tons erected.....	2.88

All the girders and I-beams were erected with steam wrecker and through spans with the derrick car. It will be noticed that the girder work cost more than the trusses, the reason for this being that a good part of the girder work was on second track, where one girder had to be cut apart and moved to the outside and a heavier girder set in its place. The bridge gang traveled over a territory of 5,000 miles and the cost of moving was also charged to the bridges. The riveting was also done by hand.

Reports on the Safety and Sufficiency of the Blackwell's Island Bridge, New York City.

One of the results of the Quebec bridge failure, as some of our readers will recall, has been to cast suspicion on the large cantilever bridge now being constructed across the East River at Blackwell's Island, New York city. The similarity not only in type but in design and details of the American structure to the ill-fated Canadian work became the cause in New York city of considerable popular apprehension. To allay this feeling the Department of Bridges arranged to have the new Blackwell's Island structure investigated in all its details. Prof. Wm. H. Burr, M. Am. Soc. C. E., was commissioned to conduct a careful study of the work and to report his findings and another, and an entirely independent investigation was arranged to be made by the engineering firm of Bolles & Hodge. These investigations have recently been completed and the findings presented in the form of reports. Ultimately these reports, which are quite voluminous, will be printed and made public, but as this will require some time the Department of Bridges has given out the conclusion of the two reports for newspaper publication, and we reprint them here:

Conclusions of the Report of Prof. Wm. H. Burr.—First—The specifications for the chemical and physical requirements of both the nickel and the carbon steels employed in the structure are satisfactory and in accord with the best practice of the present time.

Second—Both the shop and mill inspection were efficiently performed, resulting in securing excellent quality of material and the fabrication of truss members of good quality and accurate dimensions.

Third—The various members of the structure possess the full sections required by the unit stresses and the working plans, and the shipping weights correspond correctly to these sections as well as to the computed weights.

Fourth—The erection was successfully and satisfactorily performed, leaving the trusses in correct alignment and elevation.

Fifth—Computations in accordance with the specifications for the maximum floor loads show that the capacities of the floors for both the upper and lower decks are satisfactory.

Sixth—Computations for all the main truss members of the bridge show that the stresses produced by the prescribed congested live load, combined with the dead load or with the dead load and wind loading are higher than prescribed as permissible in the specifications and higher than prudent to permit, although practically not in excess of the limits approved by the Commission of Expert Engineers in 1903.

Seventh—The stresses disclosed the stress sheet submitted with this report show that a controlled traffic on the four trolley lines of the lower deck and on two

elevated railways of the upper deck carrying the heaviest cars of their classes now in use in the city of New York, together with a vehicular traffic on the roadway and two loaded sidewalks, may be permitted without exceeding the specified unit stresses for the regular live load and dead load and without exceeding the safe limits of stresses for such a structure, provided the rearrangement of the floor of the lower deck and the removal of the two elevated railway tracks on the upper deck, together with the rearrangement of the sidewalk details must be made as indicated in this report so as to reduce the dead load by at least 1,272 lbs. per linear foot of each truss of the Cantilever arms and 380 lbs. per linear foot of arch truss of the island span and anchor arms. This rearrangement and reduction of dead load can now be made without material delay in the opening of the bridge for traffic. The capacity so afforded is satisfactory and sufficient for a considerable future period. Any further use of the upper deck for elevated railway or other purposes should be deferred until the development of traffic in the future may make it necessary, and until it shall be determined what character of traffic must then be accommodated, but that adjustment to the future traffic should not be such as to produce greater unit stresses than those approved in this report.

Eighth.—The distance between trusses is suitable to this type of structure and such as to secure satisfactory lateral stability, especially in connection with the buckle plate floor.

Conclusions of the Report of Messrs. Boller & Hodge—First.—That the specifications are clear and explicit and cover all the necessary requirements for the material and workmanship of a first-class structure, but in our opinion the working stresses given are in excess of good practice.

Second.—That the steel manufactured for this structure is first-class bridge material and in accordance with the specifications.

Third.—That the workmanship of this structure is first class and in accordance with the requirements of the specifications.

Fourth.—That the erection and field riveting of the structure appears to have been done in a first-class manner.

Fifth.—That the actual sections of the various members agree with the sections ordered on the working drawings and shown on our sheets Nos. 8 and 9 and that the shipping weights are correct.

Sixth.—That the members of floor system are safe for the specified local live loads.

Seventh.—That the following unit stresses in the main truss members, viz.:

	Lbs. per sq. in.
Tension nickel steel bars..	30,000
Tension structural steel bars and riveted members	20,000
Compression structural steel, up to $L/R=20$...	10,000

Compression structural steel, for L/R above 20.. 20,000—50 L/R are the limit of safety for the direct stresses from the sum of the live and dead loads, as the secondary and snow load stresses heretofore referred to will add to these unit stresses and thereby increase the actual unit stresses.

Eighth.—That the main truss members will not carry all the specified live loads for which this structure was designed.

Ninth.—That the structure can safely carry a considerable live load in addition to its actual dead load.

As we, therefore, do not think the structure can carry all the specified live loads and yet is safe for considerable live load, we have tried to arrive at the actual live load which may safely come on this structure, using actual moving loads now in use on the subway, elevated and surface lines of the city.

The heaviest trolley car now actually in use in this city has four axles with a loaded weight of 15,500 lbs. on each axle, and an over-all length of 42 ft. 6 ins., giving an average load of 1,460 lbs. per lin. ft. of each trolley track. The heaviest elevated or subway "motor" car has two loaded axles of 30,800 lbs. each, and two loaded axles of 22,200 lbs. each, and an over-all length of 51 ft., giving an average load of 2,080 lbs. per lin. ft. of track. The heaviest elevated or subway "trailer" car has four loaded axles of 17,500 lbs. each and an over-all length of 51.4 ft., giving an average load of 1,360 lbs. per lin. ft. of track.

The average weight of an elevated or subway train made up of five motor cars and three trailer cars is thus found to be 1,810 lbs. per lin. ft. of track.

The specified live load for the main trusses is 100 lbs. per sq. ft. on the roadways and 75 lbs. per sq. ft. on the footwalks, and while we believe such loads are proper for designing local members of the floor system and secondary truss members, they are undoubtedly excessive for the main truss members, as no such load can possibly come on the entire width of the roadway and sidewalks for any considerable length of the structure. For the main truss members we, therefore, consider a live load of 50 lbs. per sq. ft. on the roadway and sidewalks to be fully sufficient.

By trial we find that the main trusses will safely carry a live load of 3,000 lbs. per lin. ft. of each truss, if the dead load be reduced by 1,000 lbs. per lin. ft. of each truss. Some of this dead load, consisting of the outer sidewalk stringers, floor-beam brackets, sidewalk gratings and track material for the railway tracks on the upper deck has never been put on the structure, and some of the dead load now on can be omitted, thus decreasing the full dead load and permitting the use of the above live load. Furthermore, the average live load on the trolley tracks can be reduced by regulating the minimum spaces between same, as these units are so small that for the main trusses the load is practically uni-

form for the cars spaced at reasonable intervals. For the elevated railway tracks it is not possible to greatly reduce the effective load per lineal foot by regulating the intervals between trains, as these trains are long and heavy units, and if trains are spaced at intervals of three or more train lengths they will fall in such position as to practically produce the maximum stresses in important parts of the structure.

With these live loads the roadway and footwalks produce a live load of $[17\frac{3}{4}$ ft. + 11 ft. = 28 $\frac{3}{4}$ ft. at 50 lbs. =] 1,437 lbs. per lin. ft. of truss, and if we assume each trolley track to be loaded with cars at clear intervals of one car length, or about 85 ft. center to center, they will produce a live load of 2×730 lbs. = 1,460 lbs. per lin. ft. of truss, making a total live load of 2,897 lbs. per lin. ft. of truss, which would require a reduction in the dead load of about 1,000 lbs. per lin. ft. of truss to meet the conditions of safety, and this reduction can be readily made.

We, therefore, come to the conclusion that it is safe to run the four lines of trolley cars on this bridge as at present constructed, if the portions of the dead load not yet in place, and not required for highway or trolley service, be omitted, and if the four lines of inside track stringers on the upper deck be removed.

The "additional" dead load then will consist of the following items:

	Lbs. per lin. ft.
Concrete subpavement of roadway...	3,200
Wood block pavement of roadway...	1,040
Rails and conductor rails for four trolley tracks	374
Concrete footwalk slabs.....	800
Six railings	406
Electric wires, gas mains, etc.....	160
	5,980
Less deduction for removing four lines of stringers.....	680

Total for bridge..... 5,300

This is 2,650 lbs. per lin. ft. of each truss, which is a reduction of 1,000 lbs. per lin. ft. of each truss from the full assumed dead load.

It will be noted that the concrete footwalk slabs are here taken at 800 lbs. per lin. ft., whereas they were taken at 500 lbs. per lin. ft. in the full dead load; this is due to the fact that in the completed structure they are intended to be 10 $\frac{1}{2}$ ft. wide, whereas those now temporarily placed on the outer lines of railway stringers are 16 ft. wide. To reach the full reduction required it will also be noted that we have reduced the allowance for wires and pipes to 160 lbs. per lin. ft. bridge.

With a live load of 50 lbs. per sq. ft. on the roadway and footwalks, and a live load of 780 lbs. per lin. ft. of each trolley track (which is equivalent to running trolley cars at intervals of 80 ft. center to center), we get a total live load of 3,000 lbs. per lin. ft. of each truss, and with this live load in addition to the total assumed dead load

reduced by 1,000 lbs. per lin. ft. of truss, we have made the complete stress sheet herewith submitted, and it will be seen that all these stresses come practically within the limits of safety, set by us, and the bridge is, in our opinion, safe for these loads.

It will be noted that the dead load stresses shown on this stress sheet are computed with the full weight of structural material shown on our sheets, 1, 2 and 3, but the total dead panel loads shown on our sheets 1 to 6 inclusive were reduced for computing these dead load stresses by a uniform deduction of 1,000 lbs. per lin. ft. truss, as above itemized.

The dead load of the floor system can be further reduced if necessary, and we are of the opinion that by reducing the dead loads on all the lever arms, and perhaps increasing the dead loads on the island span and anchor arms, the structure can be made to safely carry one pair of elevated tracks.

In our opinion the most practical method of getting this bridge into prompt service is to remove the stringers from the two inside lines of upper railway tracks and open the bridge for service of the highway, sidewalks and four trolley tracks immediately.

If at some future time it is found necessary to make use of one pair of elevated tracks, further modifications of the dead loads can be made and the outer lines of elevated railway stringers used for their true purpose, the sidewalks being removed to their final position outside the trusses.

We, therefore, make the following recommendations:

First—That the stringers of the two inside tracks on the upper decks, or other equivalent dead load, be removed to lighten the dead load.

Second—That the trolley traffic be so regulated that if four tracks are in use the cars shall not run with clear intervals between them of less than their own length.

Third—That the bridge be opened for the traffic of the sidewalks, highway and four lines of trolley tracks as at present constructed, subject to the above recommendations.

Fourth—That if any other moving loads be added to the structure, such further modifications of the dead load shall first be made as will keep the total direct stresses caused by the live and dead loads within the safe limits herein set.

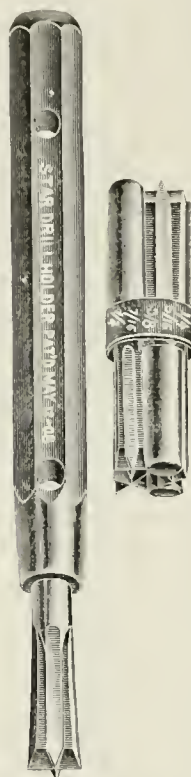
Under these recommendations we are confident the structure is perfectly safe.

The Prussian Government has authorized the city of Frankfort-on-the-Main to raise \$11,900,000 by issuing bonds. The proceeds of this loan are to be expended for municipal improvements, including extensions of the electric works and electric tramways, water and drainage system, harbor works, etc.

A New Stone and Brick Drill.

The Star Expansion Bolt Co., of Bayonne, N. J., the well known manufacturers of expansion and toggle bolts, have placed on the market the Star drill holder, and a set of special drills to fit. This outfit is meant for drilling in brick, stone, marble, tile, slate or other masonry, and it is stated that the drill does effective work, thus saving time and labor.

The holder which is made from $\frac{3}{4}$ -in. octagon tool steel, while comparatively light and easy to carry, is still solid and substantial enough to admit of taking a firm hold and striking a heavy blow, neither of which is possible with the ordinary unnecessarily



Star Drill Holder.

long brick or stone drill, without danger of breaking it. The Star drills are made in eight sizes from $\frac{1}{4}$ -in. to $\frac{3}{4}$ -in. diameter and are made with a taper shank, which fits the taper bore of the holder. After a drill has been used in the holder it naturally becomes rather firmly set in the socket, but it may very readily be started by driving through the key hole a taper key, which is furnished with the tool. Star drills are guaranteed against the breakage so common in the use of ordinary brick or stone drills.

With the holders the drill heads or blanks do not become battered down to an uneven and rounded surface, which is a great disadvantage in drilling even, clean-cut holes. The compactness of the Star drill holder and set of drills will appeal to all those who have been accustomed to carrying a full set of the long 12-in. drills in their tool boxes.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0961. **Hug Water Wheels.**—The Hug Water Wheel Co., Denver, Colo.

The Hug water wheel is an impulse wheel, and this catalog describes its construction and operation and gives results of tests and experiences. There are also complete tables of horsepower, revolutions, water consumption for various heads of water and sizes of wheels. Tables of flow of water over weirs, miners' inch measurement, friction of water in pipes and general information are given.

No. 0965. **Hoisting Machinery.**—The Reliance Tool & Machine Works, St. Louis, Mo. This catalog illustrates and describes the line of hoisting engines built by this firm. Details of parts are shown and described and the usual catalog information is given.

No. 0966. **McRoy Tile for Conduits.**—McRoy Clay Works, Chicago, Ill.

This pamphlet illustrates and describes McRoy tile conduits for underground electric transmission. The characteristics of this tile are stated and their advantages argued. All details are illustrated and described.

No. 0967. **Northern Electric Rock Drills.**—Northern Electric Mfg. Co., Madison, Wis.

The new electric rock drill described in detail in this 25-page pamphlet is wholly different in construction from previous electric drills. Owing to this construction it is asserted that a Northern drill of $1\frac{1}{2}$ to 2-HP. will do the work of an air drill requiring a boiler capacity of 15-H.P., or of any other electric drill requiring four or five times its power. The drill is described very completely and there is a general discussion of the development and advantages of electric drills. Rockmen should get a copy of this pamphlet.

No. 0968. **Aetna Dynamite.**—The Aetna Powder Co., Chicago, Ill.

This series of pamphlets is worth securing by everyone who has to do blasting. They bear the titles of "Aetna Dynamite," "Firing Blasts by Electricity," "Blasting Talks, Nos. 1 and 2," "Stump Blasting," "Lion Blasting Machines and Fuses," etc., and each is filled with suggestions, hints and instructions for blasting work.

No. 0969. **Light Locomotives.**—H. K. Porter Co., Pittsburg, Pa.

The large line of light locomotives for contractors and industrial uses made by this firm is illustrated and described in this 225-page cloth bound book. In addition to these catalog data the contractor and superintendent will find the book filled with pages of useful data for figuring hauling capacity, laying out and constructing industrial railway, cost of railway track, etc.

No. 0970. **Hoisting Engines.**—J. S. Mundy, Newark, N. J.

The complete line of hoists, hoisting engines, derrick engines, pile driver engines, dredge engines and boilers manufactured by this well known builder is described and illustrated in this 86-page catalog. Each machine is briefly described and weights, capacities, sizes, etc., are given in convenient tabular form.

No. 0971. **Prospecting and Valuing Dredging Ground With Keystone Driller.**—Keystone Driller Co., Beaver Falls, Pa.

The contents of this 112-page pamphlet consist chiefly of a series of technical articles as follows: "Prospecting and Valuing Dredging Ground" by N. C. Stines; "Prospecting for Gold with a Drilling Machine," by R. H. Postlewaite; "Dredging and Valuing Dredging Ground at Oroville," by N. B. Knox; "Prospecting and Examination of Conditions in Dredging," by L. E. Aubury; "Blasting Tight Places Before Dredging," by O. B. Finn. The erection and operation of drilling outfits are also explained and many suggestions and hints useful to prospectors are given. The pamphlet is a valuable one.

No. 0972. **Belt Conveyors.**—Stephens-Adamson Mfg. Co., Aurora, Ill.

A 75-page catalog, neatly printed and well illustrated, describing the different parts of these belt conveyors, and showing installation of conveyors for various purposes. Diagrams showing the operation of the conveyors are also given and a number of pages are devoted to the uses of belt conveyors.

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
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Nov. 18. Forman, N. Dak.....	Nov. 11
Nov. 20. Beaufort, N. C.....	Oct. 28
Nov. 20. Philadelphia, Pa.....	Nov. 18
Nov. 21. Caldwell, O.....	Nov. 18
Nov. 21. Pensacola, Fla.....	Nov. 18
Nov. 23. San Bernardino, Cal.....	Nov. 11
Nov. 23. Missoula, Mont.....	Nov. 18
Nov. 24. Barrie, Ont.....	Nov. 18
Nov. 25. Richmond, Va.....	Nov. 11
Nov. 25. Pittsburg, Pa.....	Nov. 11
Nov. 30. Havelock, N. B.....	Nov. 4
Nov. 30. Lepreau, N. B.....	Nov. 11
Dec. 5. Wichita, Kan.....	Nov. 18
Dec. 7. Grenada, Miss.....	Nov. 4
Dec. 7. Valparaiso, Ind.....	Nov. 11
Dec. 8. Princeton, Ind.....	Nov. 18
Dec. 16. Columbus, O.....	Nov. 18

Buildings.

Nov. 18. Fort Hancock, N. J.....	Oct. 28
Nov. 19. Rawlins, Wyo.....	Oct. 14
Nov. 19. La Jara, N. Mex.....	Nov. 4
Nov. 19. Pittsburg, Pa.....	Nov. 11
Nov. 20. Trinidad, Col.....	Oct. 21
Nov. 20. Soldiers Home, Cal.....	Nov. 4
Nov. 20. Utica, N. Y.....	Nov. 4
Nov. 20. Atlantic City, N. J.....	Nov. 11
Nov. 20. Bemidji, Minn.....	Nov. 11
Nov. 20. Louisville, Ky.....	Nov. 18
Nov. 21. Philadelphia, Pa.....	Oct. 28
Nov. 21. Crow Creek Agency, S. Dak.....	Nov. 4
Nov. 21. Oxford, O.....	Nov. 11
Nov. 21. Washington, D. C.....	Nov. 11
Nov. 21. Wilkesburg, Pa.....	Nov. 18
Nov. 23. Ship Island, Miss.....	Oct. 28
Nov. 23. Alfred, N. Y.....	Nov. 11
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Nov. 23. Chicago, Ill.....	Nov. 11
Nov. 23. Chicago, Ill.....	Nov. 11
Nov. 24. Baker City, Ore.....	Oct. 21
Nov. 25. Hazelton, Pa.....	Oct. 28
Nov. 25. Oakland, Cal.....	Nov. 11
Nov. 25. Brooklyn, N. Y.....	Nov. 18
Nov. 27. Milford, Del.....	Oct. 28
Nov. 27. Cincinnati, O.....	Nov. 11
Nov. 27. Providence, R. I.....	Nov. 18
Nov. 28. Prescott, Ariz.....	Nov. 18
Nov. 30. Manchester, Va.....	Oct. 28
Nov. 30. New York, N. Y.....	Nov. 18
Nov. 30. St. Joseph, Mo.....	Nov. 18
Dec. 1. Newton, Kan.....	Oct. 28
Dec. 1. Washington, D. C.....	Nov. 11
Dec. 1. Fort Hamilton, N. Y.....	Nov. 18
Dec. 2. Carlisle, Pa.....	Oct. 28
Dec. 2. Canton, N. Y.....	Nov. 18
Dec. 7. Lebanon, Ind.....	Oct. 28
Dec. 7. Denver, Colo.....	Nov. 18
Dec. 8. Gainesville, Ga.....	Nov. 4
Dec. 10. Wausau, Wis.....	Nov. 18
Dec. 14. Fort Meade, S. Dak.....	Nov. 18
Dec. 18. Madison, Wis.....	Nov. 18
Dec. 21. Seattle, Wash.....	Nov. 18
Dec. 22. Coldwater, Mich.....	Nov. 18

Roads and Streets.

Nov. 18. Brooklyn, N. Y.....	Nov. 11
Nov. 18. Opelousas, La.....	Nov. 11
Nov. 19. Oakley, O.....	Nov. 18
Nov. 19. New York, N. Y.....	Nov. 18
Nov. 19. Brooklyn, N. Y.....	Nov. 18
Nov. 19. Gadsden, Ala.....	Nov. 18
Nov. 20. York, Pa.....	Nov. 4
Nov. 20. Clearfield, Pa.....	Nov. 4
Nov. 20. Wabash, Ind.....	Oct. 28

Nov. 20. Clearfield, Pa.....	Nov. 11
Nov. 20. Milwaukee, Wis.....	Nov. 18
Nov. 20. Cincinnati, O.....	Nov. 18
Nov. 20. Bowling Green, O.....	Nov. 18
Nov. 20. Kansas City, Mo.....	Nov. 18
Nov. 20. Marquette, Mich.....	Nov. 18
Nov. 23. Ste. Emile, Que.....	Nov. 4
Nov. 23. East Liverpool, O.....	Nov. 11
Nov. 23. Columbia, S. C.....	Nov. 18
Nov. 23. Oakland, Cal.....	Nov. 18
Nov. 24. New Brighton, N. Y.....	Nov. 18
Nov. 24. Long Island City, N. Y.....	Nov. 18
Nov. 25. Uniontown, Pa.....	Nov. 11
Nov. 25. Elkhart, Ind.....	Nov. 18
Nov. 25. Brooklyn, N. Y.....	Nov. 18
Nov. 27. Cincinnati, O.....	Nov. 11
Nov. 27. Columbus, O.....	Nov. 11
Nov. 27. Cincinnati, O.....	Nov. 11
Nov. 28. Hillsdale, N. J.....	Nov. 18
Dec. 7. Vernon, Ind.....	Nov. 18
Dec. 7. Denver, Colo.....	Nov. 18
Dec. 8. Wabash, Ind.....	Nov. 18

Sewers.

Nov. 18. Steubenville, O.....	Nov. 11
Nov. 18. Rye, N. Y.....	Nov. 11
Nov. 20. Dayton, O.....	Nov. 11
Nov. 20. Marquette, Mich.....	Nov. 18
Nov. 21. Roanoke, Va.....	Nov. 4
Nov. 21. Harrisburg, Pa.....	Nov. 18
Nov. 21. Aurora, Neb.....	Nov. 18
Nov. 23. East Rutherford, N. J.....	Nov. 11
Nov. 23. Polk, Pa.....	Nov. 18
Nov. 23. Seymour, Ind.....	Nov. 18
Nov. 24. Lancaster, O.....	Nov. 18
Nov. 24. Long Island City, N. Y.....	Nov. 18
Nov. 25. Chicago, Ill.....	Nov. 18
Nov. 25. Binghamton, Tenn.....	Nov. 18
Nov. 26. Indianapolis, Ind.....	Nov. 18
Nov. 30. Washington, D. C.....	Nov. 18
Dec. 1. Guayaquil, Ecuador.....	Oct. 7
Dec. 1. Trenton, N. J.....	Nov. 18
Dec. 7. Muskegon, Mich.....	Nov. 18

Water Supply.

Nov. 18. Fort Robinson, Neb.....	Nov. 11
Nov. 18. Chicago, Ill.....	Nov. 11
Nov. 19. Pittsburg, Pa.....	Nov. 18
Nov. 21. Pensacola, Fla.....	Nov. 4
Nov. 21. Washington, D. C.....	Nov. 18
Nov. 23. Wilmington, Del.....	Oct. 21
Nov. 23. Pittsburg, Pa.....	Nov. 11
Nov. 23. Las Animas, Colo.....	Nov. 11
Nov. 23. Chicago, Ill.....	Nov. 18
Nov. 24. Meridian, Miss.....	Nov. 4
Nov. 24. Wenatchee, Wash.....	Nov. 4
Nov. 24. Reading, Pa.....	Nov. 18
Nov. 25. Chicago, Ill.....	Nov. 18
Dec. 1. Wilton, Wis.....	Nov. 18
Dec. 1. Yorkville, Ill.....	Nov. 18
Dec. 2. Covington, Ga.....	Nov. 18
Dec. 8. Meridian, Miss.....	Nov. 18
Dec. 14. Gridley, Cal.....	Nov. 18

Miscellaneous.

———. Boston, Mass.....	Street Lighting, Nov. 18
———. Harrisburg, Pa.....	Planing Mill, Nov. 18
Nov. 18. California City Point, Cal.....	Coal Hoisting Tower, Oct. 14
Nov. 18. Fort Myer, Va.....	Fences, Corrals, Oct. 28
Nov. 18. Plattsburg Barracks, N. Y.....	Electric Light System, Oct. 28
Nov. 18. Chicago, Ill.....	Cable Work, Nov. 11
Nov. 18. Chicago, Ill.....	Concrete Work, Excavation, Nov. 11
Nov. 19. San Francisco, Cal.....	Pier and Shed, Oct. 28
Nov. 19. Gendreau, Que.....	Dam, Bulkheads, Etc., Nov. 4
Nov. 19. Devil's Island, N. S.....	Breakwater Extension, Nov. 11
Nov. 19. Chicago, Ill.....	Dock Work, Nov. 11
Nov. 19. San Francisco, Cal.....	Sea Wall, Nov. 11
Nov. 20. Mobile, Ala.....	Pump Dredge, Oct. 21
Nov. 20. New York, N. Y.....	Garbage Removal, Nov. 18
Nov. 21. Cleveland, O.....	Vacuum Cleaning System, Nov. 4
Nov. 21. Columbus, Ind.....	Cut Off, Nov. 18
Nov. 23. Pelee Island, Ont.....	Wharf Extension, Nov. 4
Nov. 23. Canajoharie, N. Y.....	Conduit, Nov. 18
Nov. 24. Johnstown, Pa.....	Electric Lighting, Nov. 11
Nov. 27. Michipicoten, Ont.....	Wharf, Nov. 4
Nov. 27. Three Rivers, Que.....	Dock and Ice Breaker, Nov. 11
Nov. 27. Tampa, Fla.....	Street Lighting, Nov. 18
Nov. 27. Washington, D. C.....	Wharf, Nov. 18

Nov. 28. St. Louis, Mo.....	Dry Dock, Oct. 28
Nov. 30. Lepreau, N. B.....	Retaining Wall, Nov. 11
Dec. 1. Fort Robinson, Neb.....	Electric Light System, Etc., Nov. 11
Dec. 1. New York, N. Y.....	Aqueduct, Nov. 18
Dec. 2. Fort Sam Houston, Tex.....	Electric Light Line Extension, Nov. 11
Dec. 4. Niagara Falls, N. Y.....	Tunnel, Elevators, Etc., Nov. 18
Dec. 9. Flathead, Mont.....	Saw and Grist Mill, Nov. 18
Dec. 10. Ottawa, Ont.....	Steamer, Nov. 18
Dec. 11. Cincinnati, O.....	Power House, Nov. 18
Dec. 12. Chicago, Ill.....	Pile Pier, Nov. 4
Dec. 15. Washington, D. C.....	Steam Collier, Nov. 4
Jan. 4. Hartford, Conn.....	Street Lighting, Nov. 18

Excavation, Earth and Rock

Nov. 20. Cincinnati, O.....	Embankment, Nov. 11
Nov. 20. Warren, Minn.....	Ditch Work, Nov. 11
Nov. 20. Eldora, Ia.....	Tile Drain, Nov. 11
Nov. 20. New York, N. Y.....	Dredging, Nov. 18
Nov. 21. St. Joseph, Ill.....	Ditch Work, Nov. 18
Nov. 21. Greenville, O.....	Ditch Work, Nov. 18
Nov. 23. Sibley, Ia.....	Ditch, Tile Work, Nov. 11
Nov. 30. Los Angeles, Cal.....	Ditch Work, Oct. 21
Dec. 1. Hawaii.....	Dredging, Sept. 23
Dec. 1. Tiffin, O.....	Rock Excavation, Nov. 18
Dec. 4. Springfield, Mass.....	Earth Dam, Nov. 18
Dec. 9. Savannah, Ga.....	Dredging, Nov. 18
Dec. 14. Peoria, Ill.....	Tile Drains, Nov. 18
Dec. 22. Estherville, Ia.....	Ditch, Nov. 18

Materials, Machines, Supplies, Tools, Etc.

Nov. 18. San Francisco, Cal.....	Pumps, Turbines, Nov. 11
Nov. 19. Grand Rapids, Mich.....	Pumping Engine, Nov. 11
Nov. 19. New York, N. Y.....	Cement, Nov. 18
Nov. 20. Fort McIntosh, Tex.....	Boiler, Heater, Etc., Nov. 4
Nov. 20. Dallas, Tex.....	Valves, Nov. 18
Nov. 21. Chicago, Ill.....	Freight Elevators, Nov. 11
Nov. 21. Boston, Mass.....	Air Compressor, Nov. 11
Nov. 21. Mare Island, Cal.....	Air Compressor, Nov. 11
Nov. 23. Pittsburg, Pa.....	Filter Plant Equipment, Nov. 11
Nov. 23. Harrisburg, Pa.....	Fire Apparatus, Nov. 18
Nov. 23. Auburn, Ind.....	Pumping System, Nov. 18
Nov. 24. Meridian, Miss.....	Pumping Engines, Nov. 4
Nov. 24. Pekin, Ill.....	Boilers, Pumps, Etc., Nov. 4
Nov. 24. Augusta, Ga.....	Pump, Power Plant, Nov. 11
Nov. 24. Newton Falls, O.....	Pumps, Piping, Etc., Nov. 18
Nov. 24. Amsterdam, N. Y.....	Pipe, Specials, Nov. 18
Nov. 25. Columbus, O.....	Transformers, Etc., Nov. 18
Nov. 27. Grand Rapids, Mich.....	Sewage Pumping Machinery, Nov. 11
Nov. 27. Washington, D. C.....	Steel Dump Cars, Nov. 11
Nov. 28. Denver, Colo.....	Freight Lift, Nov. 11
Nov. 28. Chicago, Ill.....	Street Flushing Machines, Nov. 18
Nov. 30. Atlanta, Ga.....	Motor, Nov. 11
Nov. 30. Washington, D. C.....	Boilers, Tanks, Drills, Etc., Nov. 18
Nov. 30. Los Angeles, Cal.....	Tees, Bends, Etc., Nov. 18
Dec. 1. Edmonton, Alberta.....	Granite, Nov. 18
Dec. 7. Grand Forks, N. Dak.....	Fire Hose, Nov. 18
Dec. 7. Washington, D. C.....	Locomotives, Nov. 18
Dec. 8. Meridian, Miss.....	Pumping Machinery, Nov. 18
Dec. 9. Washington, D. C.....	Towing Machines, Nov. 18

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Pensacola, Fla.—Until Nov. 21, by County Commissioners, A. M. McMillan, Clerk, for constructing wooden bridge over Little Bayou.

Princeton, Ind.—Until 11 a. m., Dec. 8, by Harry R. Embree, County Auditor, for erection of 33 bridges.

Wichita, Kan.—Until Dec. 5, by County Clerk, for erecting bridges as follows: One 60-ft. pile bridge over Chisholm creek, one 16-ft. pile bridge over the same stream; one 60-ft. steel bridge in Morton Township over Spring creek; one 400-ft. pile bridge over the Ninnescah, in Viola Township; one 300-ft. pile bridge over the Ninnescah in Morton Township, and an 80-ft. pile bridge over the Cowskin in Waco Township.

Missoula, Mont.—Until 10 a. m., Nov. 23, by E. L. Smith, County Clerk, for construction of a bridge over the Missoula River at Higgins Ave., Missoula. Certified check for \$5,000 required with bid.

Caldwell, O.—Until 11 a. m., Nov. 21, by County Auditor, for re-roofing three bridges with 28-gauge galvanized sheet iron.

Columbus, O.—Until Dec. 16, by Board of Public Service, according to reports, for construction of approaches and superstructure of West Mound St. viaduct. Approaches are to be of masonry and superstructure of steel. Estimated cost is \$120,000.

Philadelphia, Pa.—Until noon, Nov. 20, by George R. Stearns, Director Public Works, for constructing a bridge.

Pittsburg, Pa.—As stated in our last issue bids are being asked by F. P. Booth, County Controller, until noon, Nov. 25, for erecting joint county bridge over the Monongahela River at Monongahela. This is a readvertisement, the low bid of \$215,000 at a previous letting having been rejected. The following is a general description of the plan and kind of a bridge required: Superstructure—Three trusses 455 ft. long each, with a 24-ft. roadway on which are two street car tracks, one 6-ft. sidewalk, floors and all wood work of treated kreodone construction. Substructure—Two river piers of stone on pile and concrete foundations and two concrete abutments with wings and reinforced with steel. Approaches are to be filled and paved. Wm. Wylie, Engineer, Washington, Pa.

Barrie, Ont.—Until noon, Nov. 24, by J. T. Simpson, Chairman Bridge Committee, County of Simcoe, Barrie, for the construction of a steel bridge over the Nottawasaga River near its mouth (Vanvleck P. O.). The bridge will be a steel superstructure of three spans (total length about 320 ft.) set on concrete abutments and piers on pile foundations and having earth embankment approaches. C. H. Mitchell, Engineer, Traders Bank Bldg., Toronto, Ont.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Prescott, Ariz.—Until 2 p. m., Nov. 28, trustees of School District, M. B. Hazeltime, Chairman, for constructing school building.

Denver, Colo.—Until noon, Dec. 7, by Frederick R. Ross, Chairman Library Commission, for furnishing book stack, elevator, fixed and movable furniture and electric fixtures. A. R. Ross, Architect, 16 East 42d St., New York City.

Louisville, Ky.—Until noon, Nov. 20, by Board Public Works, 42 City Hall, for furnishing and placing necessary marble work in annex to city hall.

Coldwater, Mich.—Until 3 p. m., Dec. 22, by James Knox Taylor, Supervising Architect, for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the postoffice at Coldwater.

St. Joseph, Mo.—Until 7:30 p. m., Nov. 30, by School Directors, H. H. Smith, Secretary, for erection of new Robidoux school, Eckel & Boschen, Architects, 6th and Edmond Sts.

Brooklyn, N. Y.—Until 10 a. m., Nov. 25, by Board of Health, 55th St. and 6th Ave., for labor and materials to erect and complete a laundry building, together with all necessary alterations and other work incidental thereto, on the grounds of the Kingston Ave. Hospital at Kingston Ave. and Fenimore St., Brooklyn.

Canton, N. Y.—Until 3 p. m., Dec. 2, by Dr. Almon Gunnison, President St. Lawrence

University, for construction complete, including heating, plumbing and electric work, for a dairy building at the State School of Agriculture, St. Lawrence University, Franklin B. Ware, State Architect, Albany, N. Y.

Fort Hamilton (Brooklyn), N. Y.—Until 11 a. m., Dec. 1, by the Constructing Q. M., for the construction, heating, plumbing and electrical wiring of one double set barracks, one double set non-commissioned officers' quarters and one double set of firemen's quarters.

New York, N. Y.—Until 2 p. m., Nov. 30, by Alfred Brooks Fry, Chief Engineer, U. S. Custom House, for certain alterations, mainly on first and mezzanine floors of U. S. Court House and Post Office, New York.

Harrisburg, Pa.—See under Bids Asked—Miscellaneous—for bids wanted for planing mill construction.

Wilkesburg, Pa.—Until Nov. 21, by John M. Lindsey, Secretary Board of Education, for constructing high school building.

Providence, R. I.—Until Nov. 27, by D. F. Hayden, Clerk Board of Education, for construction of a 6-room school building on East and Summit Sts.

Fort Meade, S. Dak.—Until 10 a. m., Dec. 14, by Capt. L. C. Scherer, Constructing Q. M., for constructing three cavalry stables and one quartermaster storehouse, and for installing plumbing, steam heating, electric wiring and electric lighting fixtures in buildings specified.

Seattle, Wash.—Until 3 p. m., Dec. 21, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction of the U. S. Government Buildings at the Alaska-Yukon-Pacific Exposition at Seattle.

Madison, Wis.—Until noon, Dec. 18, by Lew F. Porter, Secretary Capitol Commission, for furnishing and erecting steel work of south wing and central portion of the State Capitol, now under construction. Geo. B. Post & Sons, Architects, 347 Fifth Ave., New York. Official advertisement will be found elsewhere in this issue.

Wausau, Wis.—Until Dec. 10, by A. Brendemuehl, Chairman Building Committee, for erection of church for St. Stephen's Evangelical Lutheran Congregation.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Gadsden, Ala.—Until Nov. 19, by W. M. Wilson, City Engineer, for sidewalk construction.

Oakland, Cal.—Until Nov. 23, by County Supervisors, for grading, macadamizing and curbing on Cleveland Ave.

Denver, Colo.—Until noon, Dec. 7, by Frederick R. Ross, Chairman Building Committee, for grading library lot and sidewalk area and for putting in curbs, walks, etc.

Elkhart, Ind.—Until 10 a. m., Nov. 25, by T. G. Wilkinson, City Clerk, for paving South Main St. with sheet asphalt. Estimated cost \$45,227. A. M. Smith, City Engineer.

Vernon, Ind.—Until 11 a. m., Dec. 7, by I. L. Thomas, County Auditor, for constructing 2½ miles of pike road in Vernon Township.

Wabash, Ind.—Until 10 a. m., Dec. 8, by J. P. Nofziger, County Auditor, for grading, draining and graveling highway in Walt Township.

Marquette, Mich.—Until 5 p. m., Nov. 20, by Park Cemetery and Street Commission, J. F. Anderson, Clerk, for grading and macadamizing portion of Division St.

Kansas City, Mo.—Until 2:30 p. m., Nov. 20, by Robert W. Goodnow, Secretary Board Public Works, for four contracts for constructing asphalt pavements.

Hillsdale, N. J.—Until 8:30 p. m., Nov. 28, by Wm. W. Banta, Township Clerk, for grading and macadamizing several streets for a total distance of 2,656 miles. N. G. Hering, Jr., Township Engineer, Hillsdale. Bids are also asked until 8 p. m., Nov. 28, for similar work on 5.33 miles of streets.

Brooklyn, N. Y.—Until 11 a. m., Nov. 25, by Bird S. Cnler, Borough President, for improvement of portions of several streets by regulating, repaving and paving with asphalt and granite on a concrete foundation the roadways, also for regulating, grading, curbing and laying crosswalks and sidewalks on various streets.

Brooklyn, N. Y.—Until 3 p. m., Nov. 19, by Park Board, Arsenal Bldg., 5th Ave and 64th St., New York, for regulating, grading and paving or repaving with asphalt pavement on a foundation of concrete the roadway of McLaughlin Park, between Bridge

and Jay Sts., Borough of Brooklyn. Security required is \$1,000.

Long Island City (L. I.), N. Y.—Until 11 a. m., Nov. 21, by Lawrence Gresser, President Queens Borough, for street improvements consisting of regulating and repaving with granite block pavement on a sand foundation, paving with wood block pavement on a concrete foundation, paving with asphalt block pavement on a concrete foundation, regrading, curbing, recubing and repaving with wood block pavement on a concrete foundation on several streets.

New Brighton (S. I.), N. Y.—Until noon, Nov. 24, by George Cromwell, President Richmond Borough, for improving portions of several streets by regulating and repaving with wood block on concrete foundation.

New York, N. Y.—Until noon, Nov. 19, by Allen N. Spouner, Commissioner Docks, Pier A, Battery Pl., for labor and materials required for repairing asphalt pavement on North and East Rivers.

Bowling Green, O.—Until 1:30 p. m., Nov. 20, by Board of Public Service, Alex Williamson, Clerk, for improvement of Lehman Ave. Certified check for \$100 required with bid.

Cincinnati, O.—Until noon, Nov. 20, by County Commissioners, Fred Dreihls, Clerk, for the following county work: Under Specifications No. 501 For repair of the Clevs road along the east bank of the Great Miami River, from Jordan road to Harrison pike, Miami Township.

Oakley (P. O., Cincinnati) O.—Until noon, Nov. 19, by Oscar Nasche, Village Clerk, for constructing 4-ft. cement sidewalks.

Columbia, S. C.—Until Nov. 23, by County Commissioners, T. J. Weston, County Engineer, for constructing concrete sidewalks and curbing around county court house.

Aberdeen, Wash.—Until 5 p. m., Nov. 25, by P. F. Clark, City Clerk, for paving.

Milwaukee, Wis.—Until 10:30 a. m., Nov. 20, by Board Public Works, Charles J. Poetsch, Chairman, for grading and paving with stone all alleys in block 3, Valley View Land Co.'s subdivision No. 1, and block 1, Valley View Land Co.'s subdivision No. 2, in the 23d ward. Certified check for \$510 required with bid.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Until noon, Nov. 30, by District Commissioners, 427 District Bldg., for constructing concrete sewer.

Covington, Ga.—See under Bids Asked—Water Supply.

Chicago, Ill.—See under Bids Asked—Water Supply.

Chicago, Ill.—Until 11 a. m., Nov. 25, by Board Local Improvements, C. A. V. Standish, Secretary, for constructing drains in a system of streets; also for five contracts for constructing sewers.

Indianapolis, Ind.—Until Nov. 26, by Board Public Works, for constructing market house sewer system, and three other sewers.

Seymour, Ind.—Until 7 p. m., Nov. 23, by Fred Everback, City Clerk, for constructing storm sewer. Certified check for \$50 required with bid.

Marquette, Mich.—Until 5 p. m., Nov. 20, by Park Cemetery and Street Commission, J. F. Anderson, Clerk, for constructing an 8-in. and a 6-in. tile sewer in Division St.

Muskegon, Mich.—Until noon, Dec. 7, by B. H. Tellman, City Recorder, for material and labor for constructing sanitary sewer in Clinton St.

Aurora, Neb.—Until 10 a. m., Nov. 21, by Dennis Saylor, City Clerk, for constructing 6,250 ft. 8-in. vitrified pipe sewer, 20 manholes and 200 6-in. connections.

Trenton, N. J.—Until 8 p. m., Dec. 1, by Harry B. Salter, City Clerk, for constructing two sewers.

Long Island City (L. I.), N. Y.—Until 11 a. m., Nov. 24, by Lawrence Gresser, President Queens Borough, for sewer construction.

Lancaster, O.—Until noon, Nov. 24, by Board Public Service, Geo. Cunningham, Clerk, for constructing 24-in. storm water sewer.

Harrisburg, Pa.—Until noon, Nov. 21, by W. W. Caldwell, Commissioner of Highways, for constructing sewers in Beverly Place.

Polk, Pa.—Until 3 p. m., Nov. 23, by Trustees of the State Institution for Feeble-Minded of Western Pennsylvania, at the institution, J. M. Murdock, Superintendent, Polk, for the construction of a sewer system and sewage disposal plant for the In-

stitution. Work on the disposal plant consists of 3,700 cu. yds. of excavation, 1,000 cu. yds. of concrete, 30 tons of c-i. pipe and specials and 3,500 ft. of sewer pipe, with all connections and appurtenances. Work on the sewer system consists of two miles of sewers, 6 ins. x 12 ins. in diameter, 27 concrete manholes and appurtenances.

Binghamton (P. O. Memphis), Tenn.—Until noon, Nov. 25, by J. A. Omberg, Jr., Engineer, 608 Goodwyn Institute, Memphis, Tenn., for constructing sewer system for this town, to consist of about 13,000 ft. of 6-in. to 15-in. sewers.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Grisdley, Cal.—Until noon, Dec. 14, by F. G. Moesch, City Clerk, for erecting steel tank and tower. Specifications, etc., are on file at office of Engineering-Contracting, 355 Dearborn St., Chicago, Ill. Official advertisement will be found elsewhere in this issue.

Washington, D. C.—Until noon, Nov. 21, by District Commissioners, Room 427, District Bldg., for an auxiliary water system and fire protection for the Home for the Aged and Infirm, Subdivisions of Bellevue and Blue Plains, District of Columbia.

Covington, Ga.—Until 3 p. m., Dec. 21, by C. C. Brooks, Chairman Commissioners, for constructing water and sewerage systems for the city. Water works system will embrace about 400 tons of 6-in. to 10-in. cast iron pipe, one 15x110-ft. stand pipe, two compound pumping engines, one turbine pump and motor, brick pumping station, settling basin and clear water basin. Sewer system will embrace five miles of 6-in. to 15-in. vitrified clay pipe sewers, etc. J. B. McCrary & Co., Engineers, Empire Bldg., Atlanta. Official advertisement will be found elsewhere in this issue.

Chicago, Ill.—Until Nov. 23, by William McLaren, Superintendent Public Service, 519 Cook County Court House, for all the work embraced in the plans and specifications for the water supply and fire protection and sewers and sewage disposal for the new Cook County Infirmary, to be erected at Oak Forest, Ill., located on the C. & N. & P. R. R., about 18 miles from Chicago, in accordance with the plans and specifications prepared by Holabird & Roche, Architects.

Chicago, Ill.—Until 11 a. m., Nov. 25, by Board Local Improvements, C. A. V. Standish, Secretary, for three contracts for constructing water supply pipes.

Yorkville, Ill.—Until 8 p. m., Dec. 1, by Dr. McClellan, Chairman Water Works Committee, for the construction of a concrete reservoir; for 15-HP. gasoline engine, 250-gallon-per-minute rotary pump, 5.915 ft. 6-in. c-i. pipe, laid; pump house, H. D. Hallett, Consulting Engineer, Aurora, Ill.

Meridian, Miss.—Until 6 p. m., Dec. 8, (postponement), by Water Works Commission, W. F. Wilcox, Engineer, for construction of reinforced concrete reservoir.

Pittsburg, Pa.—Until 10 a. m., Nov. 19, by James P. Shaw, Director Charities and Correction, 511 Fourth Ave., for drilling and casing an 8-in. artesian well on city farm, Marshalsea.

Reading, Pa.—Until 7:30 p. m., Nov. 24, by Board of Water Commissioners, Emil L. Nuebling, Engineer, 25 North 11th St., for building about 8,000 ft. of 60-in. reinforced conduit and appurtenances for raw water for Maiden Creek sand filters.

Wilson, Wis.—Until 8 p. m., Dec. 1, by W. F. Vogel, Village Clerk, for constructing complete water works. The work will comprise approximately: A distribution pipe line system; a reinforced concrete or masonry reservoir, 60,000 and 55,000 gallons capacity; a 10-HP. deep well geared base gasoline engine; a brick building 16 ft. x 18 ft., and 8-in. well 100 ft. deep. Certified check for \$500 for complete system or \$150 for each of the three portions required with bid. Oscar Claussen, Consulting Engineer, St. Paul, Minn.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Savannah, Ga.—Dredging.—Until Dec. 9, by Col. Dan C. Kingman, U. S. Engrs., for dredging in waterway between Savannah and Fernandina, Fla.

Peoria, Ill.—Tile Drains.—Until 2 p. m., Dec. 14, by Commissioners of the Hallock and Medina Drainage District, at office of W. S. Kellogg, Attorney, 100 S. Jefferson

Ave., Peoria, for furnishing and laying 31,757 ft. of drain tile ranging in size from 8-in. to 30-in. diameter. Harmon Engineering Co., Engineers, 120 Fredonia Ave., Peoria. Official advertisement was in our Nov. 11 issue.

St. Joseph, Ill.—Ditch Work.—Until 9 a. m., Nov. 21, by Commissioners of Union Drainage Ditch No. 2, C. H. Kienle, Attorney, for work on main open ditch.

Estherville, La.—Ditch.—Until 1 p. m., Dec. 22, by S. R. Stedman, County Auditor, for constructing joint ditch No. 42 between Emmet and Palo Alto Counties.

Springfield, Mass.—Earth Dam, Etc.—Until 2 p. m., Dec. 4, by Water Commissioners, Elbert E. Lochridge, Chief Engineer, 43 Bridge St., for the construction of an earth dam as included under Little River Water Supply, Contract No. 5. The work includes the construction of an earth dam containing 135,000 cu. yds. rolled embankment, three miles of roads, gate house, spillway, etc. Hazen & Whipple, Consulting Engineers, 103 Park Ave., New York.

New York, N. Y.—Dredging.—Until noon, Nov. 20, by Allen N. Spooner, Commissioner of Docks, Pier A. Battery Pl., for the following work: Contract No. 1141, dredging about 25,000 cu. yds. of material in the Boroughs of Manhattan, Brooklyn, Queens, the Bronx and Richmond; dredging about 200,000 cu. yds. on the North River.

Greenville, O.—Ditch Work.—Until 10 a. m., Nov. 21, by James R. Marker, County Engineer, for constructing Richter ditch in Brown Township, estimated to cost \$1,765. Work includes 7,146 ft. of 10-in. to 22-in. tile.

Tiffin, O.—Rock Excavation.—Until Dec. 1, by C. J. Peters, County Engineer, for work on Silver Creek, principally rock excavation. Estimated cost is \$15,000.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Hartford, Conn.—Street Lighting.—Until Jan. 4, by Board of Contract and Supply, for lighting streets for five years. All bids for this work were recently rejected.

Washington, D. C.—Wharf.—Until noon, Nov. 27, by the Light House Engineer, Baltimore, Md., for materials and labor for the construction of a lighthouse depot wharf at the intersection of O and Water Sts., Washington, D. C.

Columbus, Ind.—Cut-Off.—Until 10 a. m., Nov. 21, by John M. Davis, County Auditor, for constructing cut-off of Flatrock River.

Tampa, Fla.—Street Lighting.—Until Nov. 27, by City Clerk, for lighting streets with 100 or more electric arc lights.

Boston, Mass.—Street Lighting.—Guy C. Emerson, Superintendent of Streets, 47 City Hall, invites parties having street lighting apparatus adapted to systems other than the present system of low-pressure gas mantles to demonstrate, if they so desire, during the continuance of the present contract for street lighting, with a view to the improvement of the present system upon the expiration of the present contract on Sept. 15, 1909.

Flathead, Mont.—Saw and Grist Mill.—Until 2 p. m., Dec. 9, by Commissioner of Indian Affairs, Washington, D. C., for furnishing materials and labor necessary to construct and complete a flour and sawmill at Ronan Subagency, Flathead, Mont. Further information may be obtained from Samuel Bellew, U. S. Indian Agent, Jocko, Mont.

Canajoharie, N. Y.—Conduit.—Until Nov. 23, for the construction of a vitrified multiple duct conduit in Church St., Canajoharie. The work consists of about 900 ft. of conduit with the necessary laterals and appurtenances. Chas. E. Perry, Engineer, Canajoharie.

New York, N. Y.—Aqueduct.—Until 11 a. m., Dec. 1, by Board of Water Supply, Thos. Hasset, Secretary, 299 Broadway, for contract 36 for the construction of the north half of the Wallkill pressure tunnel, a tunnel in rock crossing under the valley of the Wallkill River, with three shafts 350 to 480 ft. in depth, and a short stretch of plain concrete conduit, known as cut-and-cover aqueduct; and for contract 37 for the construction of the south half of the Wallkill pressure tunnel, with three shafts 350 to 400 ft. in depth, and a short stretch of plain concrete conduit, known as cut-and-cover aqueduct. The pressure tunnel will be circular, 14½ ft. inside diameter, and the aqueduct 15 ft. high by 17½ ft. wide inside. The work is located in the towns of New Paltz and Gardiner, Ulster County, New York.

New York, N. Y.—Garbage Removal.—Until noon, Nov. 20, by Commissioner of Street Cleaning, 13 Park Row, for the collection and removal of all ashes, garbage and other

light refuse and rubbish in specified districts of the Borough of the Bronx, and Inwood and Marble Hill in the Borough of Manhattan.

Niagara Falls, N. Y.—Tunnel, Elevators, Etc.—Until 10:30 a. m., Dec. 4, by Edward H. Perry, Superintendent State Reservation, for (1) construction complete, including plumbing, electric heating and lighting for shaft and tunnel, and inclined foot path; and (2) for elevators, including machinery, at the State Reservation, Niagara Falls, N. Y. Franklin B. Ware, State Architect, Albany, N. Y.

Cincinnati, O.—Power House.—Until 2 p. m., Dec. 11, by Col. Wm. I. Russell, U. S. Engrs., for building a power house at Dam No. 37, Ohio River.

Harrisburg, Pa.—Planing Mill.—Emswenger Lumber Co., Harrisburg, will receive prospective plans with an estimated cost (if the plans are accepted) for the erection of a planing mill, 68 ft. wide by 200 ft. long, one story high, including three assembling rooms, for stair building department, sash department and frame department. Boilers and engine room at opposite sides. Exhaust steam dry kilns to accommodate 200,000 ft. of lumber. Ground plot perfectly level, and includes eight acres. Building of brick or concrete and iron structural roof.

Ottawa, Ont.—Steamer.—Until noon, Dec. 10, by G. J. Desbarats, Deputy Minister of Marine and Fisheries, for the construction of a twin-screw steel steamer for the hydrographic service on the Atlantic coast, of the following leading dimensions: Length over all, 173½ ft.; breadth of beam, moulded, 29 ft.; depth, 15½ ft.; to be delivered at Sorel, in the Province of Quebec.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Los Angeles, Cal.—Teas, Bends, Etc.—Until Nov. 30, by Water Board, 440 South Hill St., for furnishing cast iron tees, crosses, bends, etc.

Washington, D. C.—Towing Machines.—Until Dec. 9, by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing, under Circular 480, 12 towing machines.

Washington, D. C.—Boilers, Tanks, Drills, Etc.—Until 10:30 a. m., Nov. 30, by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing, under Circular 478, the following: Marine boilers, automatic water-measuring tanks, oil filter, electric drills, wood-boring machine, reamers, condenser tubes, steel, copper, zinc, wire cable, metallic packing, trench braces, tamping sticks, wooden mauls, tool handles, hose attachments, bolts, nails, hooks and eyes, hinges, locks, cutlery, ice picks, kitchen utensils, glass dishes, ice-cream freezers, water coolers and filters, garbage cans, oil cans, cots, furniture, chair bottoms, bed springs, cotton waste, tallow, soap, lubricating grease, belt dressing, oils, gasoline, etc.

Washington, D. C.—Locomotives.—Until 10:30 a. m., Dec. 7, by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing, under Circular 479, ten narrow gauge locomotives.

Chicago, Ill.—Street Flushing Machines.—Until 11 a. m., Nov. 28, by Department Public Works, 200 Randolph St., for furnishing and delivering 39 street flushing machines.

Yorkville, Ill.—Engine, Pump.—See under Bids Asked—Water Supply.

Auburn, Ind.—Pumping System.—Until 1 p. m., Nov. 23, by John M. Davis, County Auditor, for furnishing and erecting complete pumping system for county asylum.

Meridian, Miss.—Pumping Machinery.—Until 6 p. m., Dec. 8 (postponement) by Water Works Commission, W. F. Wilcox, Engineer, for furnishing and erecting one 5,000-gallon, horizontal cross compound crank and fly wheel pumping engine.

Grand Forks, N. Dak.—Fire Hose.—Until 4 p. m., Dec. 7, by W. H. Alexander, City Auditor, for furnishing 1,000 ft. of 2½-in fire hose.

Amsterdam, N. Y.—Pipe, Specials.—Until 8 p. m., Nov. 24, by Chas. C. Yund, President Water Commissioners, for furnishing cast iron water pipe and special castings in the following quantities for Hanns Creek Conduit No. 2: 30-in. straight piping, 3,538 tons; 24-in. straight piping, 3,844 tons; small sizes, straight piping, 16½ tons; 30-in. special castings, 25 tons; 24-in. special castings, 20 tons; 30-in. inspection castings, 18 tons; 24-in. inspection castings, 20 tons. J. R. Snell, Superintendent Water Works. Official advertisement will be found elsewhere in this issue.

New York, N. Y.—Cement.—Until noon Nov. 19, by Allen N. Spooner, Commissioner of Docks, Pier A, Battery Pl., for furnishing and delivering the following: Class 1-A, 5,000 bbls. of cement; Class 1-B, 20,000 bags of cement.

Niagara Falls, N. Y.—Elevators.—See under Bids Asked—Miscellaneous.

Columbus, O.—Transformers, Etc.—Until Nov. 25, by Capt. H. J. Hirsch, Constructing Q. M., Columbus Barracks, for furnishing and installing transformer, etc., and making underground electric service connections to new post hospital, new bakery, disinfecting plant and new hospital corps Sergeants' Quarters at this Post.

Newton Falls, O.—Pumps, Piping, Etc.—Until noon, Nov. 24, by Trustees Public Affairs, C. W. Smith, Clerk, for the following: Pumps for water service, feed water heaters, boiler feed pumps, boiler, air compressor, air lifts and piping. Reliance Engineering Co., Engineers, Fourth National Bank Bldg., Cincinnati, O.

Harrisburg, Pa.—Fire Apparatus.—Until noon, Nov. 23, by C. A. Garverich, Chief Fire Department, for furnishing 85 ft. automatic aerial truck, and for a double 35-gallon combined chemical engine and reel hose wagon.

Dallas, Tex. Valves.—Until 3 p. m., Nov. 20, by J. B. Winslett, City Secretary, for furnishing f. o. b. cars, Dallas, one car load of valves, as follows: 2 sluice gates, 30 in. wide by 60 in. high; 2 30-in. gate valves, low pressure; 4 21-in. gate valves, high pressure; 4 20-in. gate valves, high pressure; 1 8-in. gate valve, low pressure; 56 4-in. gate valves, high pressure; 3 18-in. valves, high pressure; 6 16-in. valves, high pressure; 8 12-in. valves, high pressure; 14 10-in. valves, high pressure; 6 8-in. valves, high pressure; 6 4-in. valves, high pressure.

Edmonton, Alberta.—Granite.—Until noon, Dec. 1, by John Stocks, Deputy Minister of Public Works, for the supply and delivery of all granite, cut and ready to set, which may be required in connection with the Parliament Buildings now being erected in the City of Edmonton. The approximate amount required is 33,450 cu. ft.

CONTRACTS LET.

The following contracts have been let recently:

Headland, Ala.—Church.—J. C. Monk for building Baptist church; to be of brick and to cost \$10,000.

Fresno, Cal.—Railroad Work.—Shattuck-Edinger Co., Los Angeles, Cal., for constructing 3½ miles of standard gage railway for the Fresno Copper Co.

Liccolo, Cal.—Library.—Hoyt Bros., Santa Rosa, Cal., for erecting Carnegie library building here.

Los Angeles, Cal.—Sewers.—C. H. Luther, at \$2,400, for constructing storm sewer in Second St.; B. M. Crecevic, at \$1,810, for constructing sewer in Sunset Boulevard.

Oakland, Cal.—Bridge.—Latus & Layaz. Oakland, Cal., at \$2,523, for constructing concrete arch bridge over Peralta Creek at Galindo St.

Petaluma, Cal.—Bridge.—Wm. L. Call, for constructing bridge over Green Valley Creek for County.

Hartford, Conn.—Road Work.—O. T. Benedict, Pittsfield, Mass., at 90 cts. per lin. ft. for gravel and \$1.50 for telford, for constructing 3,669 ft. of gravel and telford road in Sharon. Town of Sharon was awarded contract for grading 1,540 ft. of road; Joseph Mascetti was awarded contract for grading 1,700 ft. All above work is for State Highway Commission.

Fort Du Pont, Del.—Building Work.—Following contracts have been let for construction work at Fort Du Pont: Lynch Brothers, Philadelphia, construction one two-company barracks, \$50,454; construction one band barracks, \$13,951; A. S. Reed & Bro. Co., of Wilmington, construction of one double firemen's quarters, \$4,990; Warren & Rittenhouse, Washington, D. C., plumbing work in two-company barracks, \$7,295; plumbing work in band barracks, \$1,620; plumbing work in the firemen's quarters, \$668; George A. Glenn & Co., Philadelphia, heating work in two-company barracks, \$4,380; heating work in band barracks, \$1,250.

Augusta, Ga.—Bridge Work.—J. H. McKenzie's Sons, Augusta, at \$20,880, for piers for draw span at Centre St. bridge for city.

Burlington, Ia.—Sewer, Paving.—Young & Buescher, at \$1.33 per lin. ft. for sewer in Washington St., and at 60 cts. per cu. yd. for grading and \$1.73 per sq. yd. for paving in Alley No. 5.

Burlington, Ia.—Pumps, Etc.—Erie City Iron Works, Chicago, Ill., was awarded contract at \$25,270, for boilers, engines and pumps complete for the Louisa-Des Moines

Drainage District, Harman Engineering Co., Peoria, Ill., Engineers. Other bids received were: Arbuckle-Ryan Co., Toledo, O., \$28,500; A. M. Lockett & Co., New Orleans, La., \$28,701. For the building, E. A. Holteman & Co., Peoria, Ill., bid \$13,477.

Council Bluffs, Ia.—Sewer Pipe.—C. Hafer for furnishing 6, 8, 10, 12 and 15-in. sewer pipe for contracts held by E. A. Wickham.

Kamish, Idaho.—Bridge.—John F. Archer & Co., Spokane, Wash., at \$17,000, for constructing steel bridge for Kamiah Bridge Co.

Bloomington, Ill.—Sewers, Water Mains.—D. H. Ryder, for laying three sewers; R. R. McGregor, at \$2,367, for constructing three sewers.

Jerseyville, Ill.—Pumping Plant.—A. M. Lockett & Co., New Orleans, La., at \$32,000, was awarded contract for engines, boilers, pumps and all foundations and sluiceways complete for the Nutwood Drainage and Levee District pumping plant for which Harman Engineering Co., Peoria, Ill., are the engineers. Other bids received were as follows: Producer gas engine outfit, Model Gas Engine Co., Chicago, Ill., \$65,600; Otto Gas Engine Works, Chicago, Ill., \$46,361. Steam plant, boilers, engines and pumps complete, Advance Engr. & Const. Co., St. Louis, Mo., \$34,987; Havemeyer Const. Co., Chicago, Ill. (not on specifications), \$28,000; Allis-Chalmers Co., Chicago, Ill. (except the boilers), \$30,860; Arbuckle-Ryan Co., Toledo, O., \$27,755; Kipp-Lackey Co., Peoria, Ill., \$21,700.

Pittsfield, Ill.—Pumping Plant.—A. M. Lockett & Co., New Orleans, La., has been awarded contract at \$46,480, for parts 1, 2 and 3, of the steam plant for the Bay Island and Nutwood Drainage and Levee District. Harman Engineering Co., Engineers. Other bids received were as follows: Gas plant, parts 1, 2 and 3: R. D. Wood & Co., Philadelphia, Pa., \$75,000; Weber Gas Engine Co., Kansas City, Mo., \$70,000; Otto Gas Engine Works, Chicago, Ill., \$69,995. Steam plant: H. J. Gebhardt, Chicago, Ill. (complete), \$99,000; Erie City Iron Works, Chicago, Ill., parts 1, 2 and 3, \$56,998; Crescent Contracting Co., Peoria, Ill., parts 1, 2 and 3 and part 6, \$57,300, \$15,650; A. M. Lockett & Co., New Orleans, La., parts 1, 2 and 3, \$46,380; Arbuckle-Ryan Co., Toledo, O., parts 1, 2 and 3, \$44,969.

Silvis, Ill.—Sewer.—C. A. Berglund, Moline, Ill., at \$12,550, according to reports, for laying 15-in. outlet sewer for this village, George Sleeth, Secretary.

Indianapolis, Ind.—Road Work.—Halloran & Haverstick Co., at \$11,500, for constructing three miles of road for county.

Indianapolis, Ind.—Sewer.—John Jenkins, at \$9.03 per lin. ft., for constructing Brightwood sewer system, to cost about \$190,000.

Lexington, Ky.—Sidewalks.—Hughes & Forman, at 12½ cts. per sq. ft. for cement sidewalks and 42 cts. per lin. ft. on guttering and curbing for improvement of Ashland Ave.

Boston, Mass.—Building Work.—Conners Bros. Construction Co., Lowell, Mass., at \$692,345, for addition of two stories to Suffolk County Court House.

Great Barrington, Mass.—Roadwork.—J. F. McCormick, East Providence, R. I., for constructing 3½ miles of state highway.

Baltimore, Md.—Addition to Jail.—David Peoples, Philadelphia, Pa., for building addition to city jail.

Detroit, Mich.—Concrete Wharf.—Great Lakes Dredge & Dock Co., Cleveland, O., at \$9,000 for constructing concrete dock in rear of municipal power house.

Kalamazoo, Mich.—School.—Geo. Rickman & Sons, for 2-story, 46x93 ft., high school building.

Ontonagon, Mich.—Jail Addition.—Fred J. Hall, for constructing addition to county jail.

St. Paul, Minn.—Sewer, Grading.—D. W. Moore, at \$11,397, for constructing sewer in Delaware Ave.; Keough Bros. at \$1,762, for grading Pascal Ave.

St. Paul, Minn.—Bridge.—A. Y. Bayne & Co., Minneapolis, Minn., at \$4,171, for constructing bridge over Phalen-Gervols Creek for Park Board.

Keithsburg, Ill.—Bridge.—Union Bridge & Construction Co., 606 New Nelson Bldg., Kansas City, Mo., for constructing substructure and erecting superstructure of steel railroad bridge over Mississippi River at Keithsburg for the Iowa Central R. R. Bridge will have ten 200-ft. spans, two of 103 ft. girders and 22 spans of 67-ft. girders. There will be four abutments and 27 concrete piers. McClintock-Marshall Co., Pittsburg, Pa., will furnish the steel.

Logansport, Ind.—Electric Light Plant.—Messinger & Sullivan for constructing city electric light plant.

Clarksdale, Miss.—Levee, Dredging.—R. H.

McWilliams, Walnut, Ill., at 14.5 cts. per cu. yd., for developing drainage district, requiring about 1,000,000 cu. yds. of dredging.

Kansas City, Mo.—Bridge Work.—Blodgett Construction Co. has been awarded contract for building north approach and abutment for the viaduct to be erected at a cost of \$133,099 over the Belt Line track at Main St. The viaduct is to be built for the Commercial Improvement Co., which has raised \$133,000 for the work, and will afterwards be turned over to the city.

Helena, Mont.—Sewer.—McGowan & Moore, at \$1,293, for constructing sewer in Walnut St.

Manchester, N. C.—Power Plant.—Thos. B. Whitted Co., Charlotte, N. C., for construction and equipment of plant for Little River Power & Transmission Co.

Albany, N. Y.—Road Work.—Bids were received Nov. 9, 11 and 13 by Frederick Shene, State Engineer and Surveyor, for a large amount of road work. The bids received Nov. 9 were as follows:

Road No. 309, Post, Ulster County, 6.48 miles: James E. Martin, \$68,029; DeGraff & Hogeboom, Bloomington, N. Y., \$60,274; McNamee & Rice, \$58,544; Thomas O'Hern, Yonkers, N. Y., \$52,117; R. S. Kasson, \$59,169; Shanley-Morrissey Co., New York, \$62,162.

Road No. 321, Reservation Road, Seneca County, 4.31 miles: Stewart, Kerbaugh, Shanley Co., \$43,209; Booth & Flinn, Pittsburg, Pa., \$44,947; H. C. Schroeder, \$37,691; F. A. Brotsch, Rochester, N. Y. (awarded contract), \$35,156; John H. Gordon, \$39,922.

Road No. 346, Sprakers, Montgomery County, 2.52 miles: D. S. Snell & Co., \$16,401; Shanley-Morrissey Co., New York, \$16,397; Central & Eastern Construction Co., Albany, N. Y. (awarded contract), \$15,723.

Road 347, Canajoharie, Montgomery County, 2.94 miles: D. S. Snell & Co., \$27,030; Joseph Walker, New Paltz, N. Y. (awarded contract), \$25,275; F. E. Ellis, \$33,634; Shanley-Morrissey Co., \$28,805; Central & Eastern Construction Co., \$25,376.

Road 392, Oak Orchard, Orleans County, 3.342 miles: W. Truesdale, \$20,551; Hollihan & Daley, \$20,372; Chambers & Grady, \$21,062; F. A. Brotsch, Rochester, N. Y. (awarded contract), \$18,342; Greece Construction Co., \$19,949; Mosher & Sommers, \$21,936; F. W. Knickenberg, Buffalo, N. Y., \$21,095; Booth & Flinn, \$21,223; Thomas Hucknell, \$20,412; Stewart, Kerbaugh, Shanley Co., \$27,556.

Road No. 412, Port Jervis, Orange County, 5.74 miles: Joseph Walker, \$56,430; J. C. Tierney, \$64,879; Bellev & Merritt, \$57,628; Shanley-Morrissey Co., \$63,503; Orange County Road Co., \$63,657; DeGraff & Hogeboom, \$55,401; Spuyten Duyvil Construction Co., \$69,081; F. J. Gallagher, \$70,034; J. E. Consalms, \$60,335.

Road No. 413, Highland Mills, Orange County, 3.27 miles: Orange County Road Construction Co., \$32,712; Joseph Walker, \$31,548; DeGraff & Hogeboom, \$30,410; Shanley-Morrissey Co., \$30,970.

Road No. 440, Philadelphia, Jefferson County, 5.4 miles: Cement Paving & Construction Co., granite \$41,839, limestone \$45,025; Brown & Low, granite \$54,881, limestone \$59,904; Buckley Construction Co., Plattsburg, N. Y., (awarded contract at \$41,609), granite \$43,202, limestone \$41,609; Spuyten Duyvil Construction Co., granite \$46,270, limestone \$43,762; Chambers & Grady, granite \$49,987, limestone \$53,172; Ripton & Murphy, granite \$65,962, limestone \$64,988; Wm. J. Semper, granite \$45,706, limestone \$45,706.

Road No. 444, Riverside Drive, Broome County, 1.14 mile: Newport Construction Co., Newport, N. Y., syenite \$11,565, trap rock \$12,186; Edwin D. Baker, syenite \$12,554, trap rock \$12,547.

Road No. 463, Manheim Center, Herkimer County, 5.52 miles: Joseph Walker, \$64,248; Brown & Lowe, \$71,382; S. A. Seymour, \$75,047; Shanley-Morrissey Co., New York, \$66,664; Buckley Construction Co., \$61,825; Bellev & Merritt, \$61,735.

Road No. 464, Salisbury Center, Herkimer County, 5.46 miles: Kingsbury Construction Co., \$15,018; Rockefeller Bros., Brooklyn, N. Y. (awarded contract at \$38,839); Hallihan Bros., \$51,072; Newport Construction Co., Newport, N. Y., \$44,406; Brown & Lowe, \$47,130; C. H. Flanagan, \$44,014; Malloy & Davis, \$39,929; Shanley-Morrissey, \$40,871; Buckley Construction Co., Plattsburg, N. Y., \$40,427; Bellev & Merritt, \$44,889.

Road No. 480, Buffalo, Monroe County, 3.02 miles: F. W. Knickenberg, Buffalo, N. Y. (awarded contract), \$33,024; Greece Construction Co., \$35,124; Booth & Flinn, Pittsburg, Pa., \$35,755; Stewart, Kerbaugh, Shanley Co., \$35,675; Mosher & Summers, Buffalo, N. Y., \$31,938; F. A. Brotsch, Jr., Rochester, N. Y., \$38,397.

Road No. 481, Despatch, Monroe County, .99 mile: Greece Construction Co., \$15,387;

Booth & Flinn, Pittsburg, Pa., \$16,231; Monroe Roads Co., Pittsford, N. Y. (awarded contract), \$12,550; Stewart K. Shanley, \$14,315; F. A. Brotsch, Jr., \$13,412; A. J. Rockwood, \$14,897; Newport Construction Co., Newport, N. Y., \$17,440.

Road No. 489, Tully, Onondaga County, 4.44 miles: Stewart, Kerbaugh, Shanley Co., \$42,175; Booth & Flinn, Pittsburg, Pa., \$38,052; A. J. Rockwood, Rochester, N. Y. (awarded contract), \$36,646.

Road No. 491, Hilton, Monroe County, 1.01 miles: John Boylin, Barnards, N. Y. (awarded contract), \$7,788; Greece Construction Co., \$8,478; F. A. Brotsch, \$9,476; Booth & Flinn, Pittsburg, Pa., \$9,402; Stewart K. Shanley, \$9,061; Thomas Hucknell, \$8,041; P. J. Cole, \$8,164.

Road No. 493, Mendon, Monroe County, 6.26 miles: Monroe Roads Co., Pittsford, N. Y., \$52,513; F. A. Brotsch, Jr., \$56,983; Greece Construction Co., \$52,129; A. J. Rockwood, \$52,561; Mosher & Summers, Buffalo, N. Y. (awarded contract), \$51,621; Hollihan & Daley, \$48,308; Booth & Flinn, Pittsburg, Pa., \$54,565; Stewart K. Shanley, \$57,757.

Road No. 504, Troy, Rensselaer County, 1.69 miles: Elmore & Hamilton, Albany, N. Y., \$15,905; Thomas H. Karr, Troy, N. Y. (awarded contract), \$14,245; Fred E. Ellis, \$22,454; Central & Eastern Construction Co., \$15,774; Reardon & Gilchrist, \$16,512.

Road No. 536, Schoharie, Rensselaer County, 5.19 miles: Rockefeller Bros., Brooklyn, N. Y. (awarded contract), \$49,895; Elmore & Hamilton, Albany, N. Y., \$50,179; Joseph Walker, New Paltz, N. Y., \$55,169; Thomas H. Karr, \$50,515.

Road No. 543, Johnstown, Fulton County, 6.35 miles: Kingsbury Construction Co., \$46,559; Brown & Lowe, Schenectady, N. Y., \$52,326; Buckley Construction Co., Plattsburg, N. Y., \$47,288; Rockefeller Bros., \$46,140; DeGraff & Hogeboom, Bloomington, N. Y. (awarded contract), \$41,680; Malloy & Davis, Schenectady, N. Y., \$43,855; Bellow & Merritt, \$49,481; Linehan & Burnham Co., \$47,645; Shanley-Morrissey Co., New York, \$50,161.

Road No. 547, Willits, Nassau County, 6.43 miles: Andrews Bros., \$69,120; Bellow & Merritt, \$69,428; Henry J. Mullen, \$68,310; Twombly & Eldert, \$74,183; Robertson & Gerehart, \$65,125; Long Island Construction & Supply Co., Long Island City, N. Y. (awarded contract), \$63,190.

Road No. 553, Fly, Onondaga County, 2.33 miles: Stewart K. Shanley, \$17,900; Booth & Flinn, Jr., Pittsburg, Pa., \$19,416; F. A. Brotsch, Rochester, N. Y. (awarded contract), \$15,565; C. H. Flanagan, \$19,333.

Road No. 554, Fabius, Onondaga County, 4.91 miles: Booth & Flinn, \$41,695; Stewart, Kerbaugh, Shanley Co., \$49,826; Joseph McCormick, Jr., Providence, R. I. (awarded contract), \$41,526.

The following bids were received on Nov. 11 for road work:

Road No. 564, Rome, Oneida County, 5.02 miles: Newport Construction Co., Newport, N. Y., syenite \$42,057, trap rock \$48,116; Brown & Lowe, Schenectady, syenite \$47,149, trap rock \$54,409; Buckley Construction Co., Plattsburg, N. Y., syenite \$51,450, trap rock \$51,450; C. H. Flanagan, Albany, N. Y., syenite \$41,154, trap rock \$57,116; Hyde & Hyde, syenite \$54,142, trap rock \$57,096; Stewart, Kerbaugh, Shanley Co., syenite \$54,262, trap rock \$56,095.

Road No. 571, Troy, Rensselaer County, 2.61 miles: Thomas H. Karr, Troy, N. Y. (awarded contract), \$20,323; Newport Construction Co., Newport, N. Y., \$23,604.

Road No. 585, Towners Corners, Putnam County, 3.93 miles: John F. Creeden, New York, N. Y., \$37,145; H. B. Sproul, \$36,841; Ryan & Yale, \$37,934; J. E. Martin, \$37,481; Amos D. Bridges Sons, \$38,438; John Turnname, \$38,857.

Road No. 604, Troy, Albany County, 3.88 miles: Elmore & Hamilton, Albany, N. Y., \$31,935; S. B. Van Wagenen, Rondout, N. Y., \$35,451; Brown & Lowe, Schenectady, N. Y., \$33,558; M. Kantrowitz, Albany, N. Y., \$32,924; Malloy & Davis, Schenectady, N. Y., \$31,023; John Harrigan, New York, N. Y. (awarded contract), \$27,697; Harvey Leamon, Schenectady, N. Y., \$36,060.

Road No. 610, Mechanicville, Saratoga County, 7.42 miles: Shanley-Morrissey Co., New York, \$74,666; R. F. Hudson, Melrose, Mass., \$71,992; Reardon & Gilchrist, Glen Falls, N. Y., \$72,598; Kingsbury Construction Co., Sandy Hill, N. Y., \$64,215; Thomas H. Karr, Troy, N. Y., \$61,873; Putnam & Hare, New York, N. Y., \$70,009; Spuyten Duyvil Construction Co., New York, N. Y., \$89,404; Malloy & Davis, Schenectady, N. Y., \$63,793; C. H. Flanagan, Albany, N. Y., \$70,501; Elmore & Hamilton, Albany, N. Y., \$62,874; Joseph Walker, New Paltz, N. Y., \$63,665; Newport Construction Co., Newport, N. Y., \$67,987; Linehan & Burnham, Glens Falls, N. Y., \$64,217; Gailor & Fov, Saratoga

Springs, N. Y., \$66,719; Buckley Construction Co., Plattsburg, N. Y., \$66,584.

Road No. 612, Pawling, Dutchess County, 2.92 miles: Shanley-Morrissey Co., New York, \$32,957; Sam Beskin, \$33,756; Bellow & Merritt, \$30,526; H. B. Sproul, \$34,806; Lane Construction Co., Meriden, Conn., \$32,691; J. E. Martin, \$31,564; Joseph Walker, New Paltz, N. Y., \$29,323; General Construction Co., \$29,918.

Road No. 627, Wicopce, Dutchess County, 8.1 miles: H. B. Sproul, \$62,964; Shanley-Morrissey Co., New York, \$69,883; S. B. Van Wagenen, \$63,073; MacNamee & Rice, \$63,666; J. E. Martin, \$67,717; Sam Beskin, \$69,620; J. E. Consalus, \$56,474; Lane Construction Co., Meriden, Conn., \$60,262; H. S. Kasson, \$64,129; Joseph Walker, New Paltz, N. Y., \$58,793; Bellow & Merritt, \$61,238; J. F. Creeden, New York, N. Y., \$66,837; Elmore & Hamilton, Albany, N. Y., \$64,274.

Road No. 630, Troy, Sec. 4, Albany County, 2.24 miles: Harvey Leamon, Schenectady, N. Y., \$22,720; Brown & Lowe, Schenectady, N. Y., \$21,026; Morris Kantrowitz, Albany, N. Y., \$19,966; Elmore & Hamilton, Albany, N. Y., \$19,582; P. E. Ellis, Melrose, Mass., \$20,808; John Harrigan, New York, \$16,726; Malloy & Davis, Schenectady, N. Y. (awarded contract), \$19,331.

Road No. 635, Geneva, Ontario County, 5.04 miles: Nelson, Meredith Co., Chambersburg, Pa., \$45,273; Edward Suybolt, \$45,882; Hulahan & Daley, \$38,206; H. B. Burgard, Buffalo, N. Y., \$40,968; Chambers & Grady, \$45,114; Spuyten Duyvil Cons. Co., N. Y., \$41,293; A. J. Rockwood, Rochester, N. Y., \$40,245; Monroe Roads Co., Pittsford, N. Y., \$37,917; Mosher & Summers, \$41,626; F. A. Brotsch, Rochester, N. Y., \$43,701; J. F. Dolan Construction Co., \$42,357; Booth & Flinn, Pittsburg, Pa., \$43,108; H. C. Schroeder, \$43,581; Greece Construction Co., \$38,310; Stewart, Kerbaugh, Shanley Co., \$47,479; E. M. Love & Son, \$41,434.

Road No. 636, Stanley, Ontario County, 3.16 miles: Monroe Roads Co., \$17,334; Nelson Meredith Co., \$24,704; Hulahan & Daley, \$20,563; F. A. Brotsch, \$23,081; Spuyten Duyvil Construction Co., \$23,104; Greece Construction Co., \$21,450; H. B. Burgard Co., \$23,064; Stewart, Kerbaugh, Shanley Co., \$23,838; John F. Dolan Construction Co., \$22,532; H. C. Schroeder, \$22,933; Booth & Flinn, \$25,511; Mosher & Summers, \$22,420; A. J. Rockwood, \$21,961; E. M. Love & Son, \$23,877.

Road No. 642, Angola, Erie County, 6.9 miles: Erie County Board of Supervisors, \$88,605; Mosher & Summers, Buffalo, N. Y., \$84,630; Frank L. Cohn, \$86,012; Booth & Flinn, \$95,153; Joe Dunfee, \$84,583; H. B. Burgard, \$88,952; E. M. Love & Son, \$100,856; Stewart, Kerbaugh, Shanley Co., \$67,144.

Road No. 644, Alden, Erie County, 7.3 miles: Erie County Board of Supervisors, \$8,456; F. W. Knickenburg, \$8,417; Stewart, Kerbaugh, Shanley Co., \$9,907.

Road No. 645, Orchard Park, Erie County, 4.64 miles: F. L. Cohn, \$58,463; Stewart, Kerbaugh, Shanley Co., \$62,740; Mosher & Summers, Buffalo, \$60,527; Booth & Flinn, Pittsburg, Pa., \$56,434; F. W. Knickenburg, \$57,759; Greece Construction Co., \$56,923; H. B. Burgard, \$59,028; Erie County Board of Supervisors, \$60,224; J. Dunfee, Buffalo, N. Y., \$56,538; Thomas Pucknell, \$56,933; E. M. Love & Son, \$58,048.

Road No. 646, Indian Fields, Albany County, 4.12 miles: Morris Kantrowitz, Albany, N. Y., \$37,712; Frank J. Gallagher, \$44,421; C. H. Flanagan, \$38,808; J. H. Gordon, \$26,795; Malloy & Davis, \$39,350; H. B. Sproul, \$38,156; Spuyten Duyvil Construction Co., \$39,330; Joseph Walker, New Paltz, N. Y., \$32,851; Thomas H. Karr, Troy, N. Y., \$40,541; S. B. Van Wagenen, \$36,858; Edward K. Uthe, \$43,782; Shanley-Morrissey Co., \$40,111; Elmore & Hamilton, Albany, N. Y., \$35,159.

Road No. 650, Hudson, Columbia County, 5.66 miles: Goodwin Construction Co., \$89,502; H. B. Sproul, \$61,217; Elmore & Hamilton, Albany, N. Y., \$54,546; Spuyten Duyvil Construction Co., N. Y., \$63,101; Joseph Walker, New Paltz, N. Y. (awarded contract), \$56,317; Shanley-Morrissey Co., \$63,003; J. F. Creeden, New York, N. Y., \$59,673.

Road No. 652, Champlain, Clinton County, 2.25 miles: W. B. Spellman, Chateauquay, N. Y. (awarded contract), \$22,108; J. F. Creeden, New York, \$24,808; Kingsbury Construction Co., \$22,176; Spuyten Duyvil Construction Co., New York, \$26,691; Buckley Construction Co., Plattsburg, N. Y., \$24,068.

Road No. 654, Oswego, Oswego County, 5.35 miles: Thomas O'Brien, local stone \$56,643, syenite \$62,020; W. J. Semper, local stone \$50,305, syenite \$55,145; Spuyten Duyvil Construction Co., N. Y., local stone \$46,460, syenite \$70,011; Casey & Murray, Rochester, N. Y., local stone \$48,528, syenite \$60,282; C. H. Flanagan, local stone \$50,020, syenite \$64,910; Burns Bros. & Halev, local stone \$55,385, syenite \$63,844; Booth & Flinn; Chambers & Grady, local stone \$43,443, syenite

\$62,498; Stewart, Kerbaugh, Shanley Co., local stone \$54,950, syenite \$64,519; Central & Eastern Construction Co., Albany, N. Y., local stone \$50,685, syenite \$54,042; J. H. Conners, local stone \$51,905, syenite \$55,635.

Road No. 663, Otsele, Chenango County, 4.42 miles: Delaware Construction Co., limestone \$56,687, syenite \$56,238; Booth & Flinn, limestone \$52,547, syenite \$46,138; J. H. Gordon, limestone \$48,234, syenite \$47,521; Casey & Murray, limestone \$58,008, syenite \$53,014; Stewart, Kerbaugh, Shanley Co., limestone \$56,367, syenite \$52,408.

Road No. 681, Ithaca, Tompkins County, 5.23 miles: Casey & Murray, limestone \$62,527, syenite \$64,200, trap \$64,758; Standard Construction Co., limestone \$55,177, syenite \$57,854, trap \$58,524; Spuyten Duyvil Construction Co., limestone \$62,638, syenite \$66,886, trap \$69,031; A. J. Rockwood, limestone \$56,058, syenite \$62,751, trap \$63,309; P. D. Conley, limestone \$55,659, syenite \$57,333, trap \$59,006; Stewart, Kerbaugh, Shanley Co., limestone \$59,899, syenite \$64,519, trap \$66,856; A. P. Robinson, limestone \$62,870; syenite \$67,890, trap \$70,490.

Road No. 685, Stirling, Cayuga County, 5.23 miles: Chambers & Grady, syenite \$56,571, trap \$59,602; Casey & Murray, Rochester, N. Y., syenite \$55,736, trap \$57,574; Burns Bros. & Halev, syenite \$58,268, trap \$59,865; Stewart, Kerbaugh, Shanley Co., syenite \$57,423, trap \$60,032.

Road No. 690, Mosby, Rockland County, 4.25 miles: Shanley-Morrissey Co., \$38,046; Bellow & Merritt, \$33,055; J. F. Creeden, New York, N. Y., \$36,062; J. E. Consalus, \$28,450; Rowe Contracting Co., \$38,755; Fuso Gurnee Co., \$25,654.

The bids received Nov. 13 were as follows:

Road No. 708, Sidney, Otsego County, 4.68 miles: Delaware Construction Co., gneiss \$50,721, trap \$50,722, limestone \$45,511, granite \$50,722; Newport Construction Co., Newport, N. Y., gneiss \$38,592, trap \$43,715, limestone \$42,172, granite \$18,260; Elmore & Hamilton, Albany, N. Y., gneiss \$37,217, trap \$37,217, limestone \$31,715, granite \$37,217; John Harrigan, New York, N. Y., gneiss \$35,040, trap \$35,541, limestone \$32,541, granite \$35,040.

Road No. 713, North Tonawanda, Niagara County, 5.13 miles: Thomas Hucknell, \$43,542; E. M. Love & Son, \$35,671; Stewart, Kerbaugh, Shanley Co., \$41,780; Greece Construction Co., Rochester, N. Y., \$39,383; Hoff & Shannon, \$41,425; Bellow & Merritt, \$38,706; John P. Johnson, \$42,886; Frank L. Cohen, \$46,680; H. C. Schroeder, \$44,441; Booth & Flinn, \$48,823; Mosher & Summers, Buffalo, N. Y., \$43,430; Joe Dunfee, Syracuse, N. Y., \$44,737; F. A. Brotsch, \$45,775.

Road No. 714, Dansville, Livingston County, 5.37 miles: Booth & Flinn, \$61,008; Mosher & Summers, Buffalo, N. Y., \$60,830; Henry C. Schroeder, \$56,148; Greece Construction Co., \$56,945; A. J. Rockwood, \$59,120; Chambers & Grady, \$61,142; H. P. Burgard Co., Buffalo, N. Y., \$63,280; Bellow & Merritt, \$58,195; Hollihan & Daley, \$57,957; Stewart, Kerbaugh, Shanley Co., \$65,058; E. M. Love & Son, \$57,124.

Road No. 723, Whitehall, Washington County, 4.72 miles: John F. Creeden, \$83,407; Buckley Construction Co., Plattsburg, N. Y., \$34,339; James Anderson, \$35,403; Bellow & Merritt, \$36,306; Clinton Beckwith, \$37,101; W. J. Semper, \$34,447; Kingsbury Construction Co., \$35,030; P. E. Ellis, \$42,506; Malloy & Davis, Schenectady, N. Y., \$34,492; Newport Construction Co., Newport, N. Y., \$36,060; Joseph Walker, \$35,137; Reardon & Gilchrist, \$34,942; Putnam & Hare, \$31,609; Linehan & Burnham, \$36,009; Shanley-Morrissey Co., \$37,685.

Road No. 725, Grand Central Ave., Chemung County, .9 mile: J. C. Bradley, \$16,224; Casey & Murray, \$14,112; Costello & Neagle, \$18,379.

Road No. 727, Chittenango, Madison County, 5.15 miles: No bids received owing to error in advertising.

Road No. 734, Potsdam, St. Lawrence County, 5.120 miles: Casey & Murray, \$38,333; Cement Paving & Construction Co., \$41,280; Spuyten Duyvil Construction Co., \$36,334; McRoberts & Doyle, \$41,496; W. J. Semper, \$38,271; Buckley Construction Co., Plattsburg, N. Y., \$40,081; Stewart, Kerbaugh, Shanley Co., \$39,237.

Road No. 736, North Creek, Warren County, 4.12 miles: Lee Wadell, \$31,698; Shanley-Morrissey Co., New York, N. Y., \$28,105; R. S. Kasson, \$41,729; Bellow & Merritt, \$33,324.

Road No. 737, Cortland, Cortland County, 5.79 miles: Newport Construction Co., Newport, N. Y., trap \$62,238, syenite \$59,059; Booth & Flinn, trap \$61,688, syenite \$57,994; Casey & Murray, syenite \$55,909; Spuyten Duyvil Cons. Co., trap \$58,577, syenite \$54,543; C. H. Flanagan, trap \$59,191, syenite \$52,023; Chambers & Grady, trap \$55,346, syenite \$47,878; Stewart, Kerbaugh & Shan-

ley Co. trap \$61,036, syenite \$56,241; A. P. Robinson, trap \$62,379, syenite \$56,165.

Road No. 747, Delhi, Delaware County, 5.91 miles: Casey & Murray, trap \$72,624, local \$59,241; Delaware Construction Co., trap \$76,491, local \$65,829; John P. Clancy, trap \$67,209, local \$60,450; John Harrigan, New York, N. Y., trap \$55,638, local \$50,067; John P. Creedon, trap \$66,027, local \$58,280; Bellev & Merritt, trap \$67,396, local \$59,567; Malloy & Davis, Schenectady, N. Y., trap \$66,122, local \$52,146.

Road No. 750, Clarence, Erie County, 5.95 miles: Greece Construction Co., \$67,646; Booth & Flinn, \$79,284; Hulahan & Daley, \$61,831; Mosher & Summers, Buffalo, N. Y., \$66,187; A. J. Rockwood, \$74,272; Erie County Board of Supervisors, \$68,310; F. A. Brotsch, \$70,369; F. W. Kulekberg, Buffalo, N. Y., \$66,632; Frank L. Cohn, \$66,747; J. Dunfee, \$59,093; J. P. Johnson, \$64,829; Thomas Hucknall, \$64,491; Stewart, Kerbaugh, Shanley Co., \$67,235.

Road No. 754, Bath, Steuben County, 1.46 miles: J. C. Bradley, \$14,794; Booth & Flinn, Pittsburg, Pa., \$13,692; Stewart, Kerbaugh, Shanley Co., \$12,567.

Road No. 768, Ossining, Westchester County, 5.86 miles: Shanley-Morrissey Co., New York, \$57,698; Joseph Walker, \$50,653; Delecco Construction Co., \$44,698; Rowe Construction Co., \$57,341; J. S. Martin, \$47,695; H. B. Sproul, \$49,520; S. L. Waller, \$59,658; McNamee & Rice, \$53,249; Bellev & Merritt, \$51,973; Goodwin Construction Co., \$62,737; W. F. McCabe, \$54,725.

Road No. 769, Amawalk, Westchester County, 4.21 miles: General Construction Co., \$31,486; Shanley-Morrissey Co., New York, N. Y., \$36,955; F. H. Fowler Construction Co., \$42,147; John P. Creedon, \$32,710; Rowe Construction Co., \$37,453; Bellev & Merritt, \$33,091; McNamee & Rice, \$37,808; Genung & Hoyt, \$41,496; Delecco Construction Co., \$27,297; John Twinnan, \$36,741; Malloy & Murray, \$40,320; H. B. Sproul, \$32,768; W. F. McCabe, \$34,925.

Road No. 770, Golden Bridge, Westchester County, 3.85 miles: Bellev & Merritt, \$31,768; McNamee & Rice, \$37,076; John P. Creedon, \$32,159; Genung & Hoyt, \$43,683; Rowe Construction Co., \$36,446; F. G. Fowler Construction Co., \$40,506; John Twinnan, \$34,232; Malloy & Murray, \$37,159; Delecco Construction Co., \$26,832; H. B. Sproul, \$30,060; W. F. McCabe, \$35,230; Shanley-Morrissey Co., \$35,212; A. D. Bridge's Sons, \$31,120.

Road No. 784, Cooperstown, Otsego County, 3.12 miles: Spuyten Duvil Construction Co., \$34,163; A. Schaupp, \$33,607; Elmore & Hamilton, Albany, N. Y., \$30,556; Hallinan Bros., \$39,089; Buckley Construction Co., Plattsburg, N. Y., \$36,163; D. L. Snell & Co., \$35,145; Newport Construction Co., Newport, N. Y., \$34,280; Malloy & Davis, \$31,431; Delaware Construction Co., \$41,174; John Harrigan, New York, \$30,573; Shanley-Morrissey Co., New York, \$34,349.

Road No. 788, South Schenectady, Schenectady County, 7.32 miles: Morris Kantowitz, Albany, N. Y., syenite \$73,216, local \$60,411; limestone \$67,916; Buckley Construction Co., Plattsburg, N. Y., syenite \$80,118, local \$69,102, limestone \$78,278; Malloy & Davis, Schenectady, N. Y., syenite \$67,984, local \$57,964, limestone \$64,227; Chamber & Grady, syenite \$89,924, local \$71,136, limestone \$89,224; Brown & Lowe, syenite \$77,971, local \$61,761, limestone \$71,410; R. F. Hudson, syenite \$74,481, local no bid, limestone no bid; Casey & Murray, syenite \$80,723, local \$64,026, limestone \$77,086.

Road No. 794, Huntington, Suffolk County, 10.14 miles: Casey & Murray, \$98,276; Fred T. Loy & Co., \$105,818; Long Island Construction & Supply Co., \$96,766; F. J. Gallagher, Brooklyn, N. Y., \$106,366; J. F. Creedon, \$89,556; H. L. Mullen, \$87,376; Bellev & Merritt, \$91,109; Robertson-Gerehart, \$89,934.

Road No. 795, Jeffersonville, Sullivan County, 6.2 miles: Shanley-Morrissey, \$58,527; Joseph Walker, New Paltz, N. Y., \$52,589; Casey & Murray, \$70,251; Bellev & Merritt, \$49,902; J. F. Clancy, \$58,568; Clinton Beckwith Co., \$60,507.

Road No. 796, Greenville, Green County, 4.62 miles: Morris Kantowitz, \$41,342; Thomas O'Hern, Yorkers, N. Y., \$36,925; O'Connor & McIntyre, \$42,784; Joseph Walker, \$25,515; Newport Construction Co., Newport, N. Y., \$40,660; John E. Consalus, \$28,437; Clinton Beckwith Co., \$39,902; Edward Pithé, \$28,079; R. F. Hudson, \$43,419; Shanley-Morrissey Co., \$41,813.

Brooklyn, N. Y.—Water Mains.—T. A. Gillespie Co., Westinghouse Bldg., Pittsburg, Pa., at about \$2,000,000 for delivering and laying 16 in. water mains in this Borough of Brooklyn.

Buffalo, N. Y.—Sewer—Series & Fanning, at \$1,465, for sewer in Hedley St.

Buffalo, N. Y.—Street Work—Frank V. E. Bardol, for grading, macadamizing and

curbing Penhurst Park for the Penhurst Park Co.

Utica, N. Y.—Plumbing, Sewer.—O'Shea & Larkin, Rome, N. Y., at \$24,955, for plumbing and constructing sewer at new county hospital.

Schenectady, N. Y.—Clubhouse.—Austin Simkins, for erection of \$15,000 clubhouse for Schenectady Boat Club.

Sherman, N. Y.—Water Works.—F. T. Benson & Co., Falconer, N. Y., at \$15,375, for constructing water works for this place.

Watertown, N. Y.—Building.—C. D. Hodge & Co., Watertown, for erection of new Jefferson County Telephone Co.'s building.

Columbus, O.—Sewer.—C. T. McCracken & Co., at \$17,779, for building 30-in. brick storm sewer in Scott St.

Portsmouth, O.—Paving.—Monroe & Son, at \$1,899, for paving on Murray St.

Wyoming (P. O., Cincinnati), O.—Sewer System.—Thomas P. Strack, at \$32,000, for constructing sewer system and disposal plant for this place.

Zanesville, O.—Bridge Abutment.—Clifton Bros., at \$2,698, for new abutment for Taylorsville draw bridge.

La Grande, Ore.—Court House.—S. R. Howard, La Grande, for erecting court house for Wallace County; to be of native stone with granite facing.

Altoona, Pa.—Sewer.—E. A. Herr for constructing sewer in Crawford Ave.

Donora, Pa.—Electric Railway.—Frank Donatella, Pittsburg, Pa., for constructing four miles of railway for the Donora & Eldora Street Ry. Co.

Kingstree, S. C.—Bridge.—R. E. & E. N. Beatty, Georgetown, S. C., at \$1,178, for constructing reinforced concrete bridge in this city.

Salt Lake City, Utah.—Curb and Gutter.—Following bids were received Oct. 23 by this city, L. C. Kelsey, City Engineer, for curb and gutter extension No. 6, (1) standing for Jas. Kennedy Construction Co., and (2) for P. J. Moran:

	(1)	(2)
Abutters' Portion:		
Excavation, cu. yds., 198.7.....	\$0.65	\$0.50
Cement curb, steel reinforced,		
6x16 in., curved, lin. ft.,		
102.18	1.20	1.16
6x16 & 30 in. gutter, lin. ft., 48.0	1.35	1.39
Cement Curb, Plain—		
6x16 & 30 in. gutter, lin. ft.,		
104.82	1.00	1.04
6x24 & 30 in. gutter, lin. ft.,		
25.0	1.10	1.11
Furnishing and Laying Vit. Pipe—		
4-in., lin. ft., 40.0.....	.25	.28
6-in., lin. ft., 79.0.....	.35	.35
10-in., lin. ft., 85.0.....	.60	.59
12-in., lin. ft., 55.27.....	.85	.70
30-in. gutter, plain, 342.91.....	.75	.70
1-in. mesh screen for 4-in. pipe,		
sq. ft., 1.0.....	1.00	2.09
Storm water outlets, 2.....	10.00	9.72
Total abutters' portion, from		
10th to 11th East.....	\$1,799.72	\$1,785.10
Abutters' Portion:		
Excavation, cu. yds., 12,805.0.....	.65	.50
Cement Curb, Steel Rein.—		
6x16 in. curved, lin. ft., 50.78.....	1.20	1.16
6x16 & 30 in. gutter, lin. ft.,		
16.0	1.35	1.39
Cement Curb, Plain—		
6x16 & 30 in. gutter, lin. ft.,		
1,266.0	1.00	1.04
6x24 & 30 in. gutter, lin. ft.,		
15.0	1.10	1.11
30-in. gutter, plain, lin. ft.,		
106.28	.75	.70
30-in. gutter, curved, lin. ft.,		
22.78	1.00	.83
Furnishing and laying 12-in.		
vitrified pipe, lin. ft., 100.0.....	.85	.70
Storm water inlets No. 2, 1.....	20.00	13.90
Storm water outlets, 1.....	10.00	9.72
Removing trees, 6 in. to 1 ft., 8	7.00	5.56
1 ft. and over, 3.....	10.00	6.94
Total abutters' portion, from		
11th to 12th East.....	\$9,991.18	\$8,058.58
City's Portion:		
Excavation, cu. yds., 13,676.4.....	.65	.50
Cement curb, steel reinforced,		
6x16 in., curved, lin. ft., 47.1.....	1.20	1.16
Cement curb, plain, 6x16 & 30		
in. gutter, lin. ft., 350.91.....	1.00	1.04
30-in. gutter, curved, lin. ft.,		
56.95	.75	.83
4-in. cement sidewalk, sq. ft.,		
713.8	.20	.16
Cement steps, sq. ft., 180.0.....	.90	.83
Checks stony steps, lin. ft., 61.6	.30	.83
Furnishing and Laying Vit. Pipe—		
12-in., lin. ft., 199.73.....	.85	.70
10-in., lin. ft., 30.0.....	.60	.59
6-in., lin. ft., 21.0.....	.35	.35
1-in. mesh screen for 6-in. pipe,		
sq. ft., 1.....	1.00	2.00
Storm water inlets No. 2, 2.....	50.00	41.65
Total city's portion.....	\$9,996.15	\$7,870.00
Grand total	\$21,785.05	\$17,723.76

Fort Worth, Tex.—School Building.—Innes & Graham, at \$38,000, for erecting 15-room school building.

Tyler, Tex.—Court House.—W. C. Whitney, Beaumont, Tex., for erection of \$150,000 court house.

Dinwiddie, Va.—School Houses.—C. E. Market for erecting two school houses.

Harrisonburg, Va.—Buildings.—W. M. Bucher & Son, for erection of one dormitory and one academic building for State Normal School.

Spokane, Wash.—Street Improvements.—Contracts for street improvements have been let as follows: Grading on 11th Ave., Thomas Maloney for Federal Labor Union, \$2,232; grading 7th Ave., Julia V. Costello, \$6,650.

Spokane, Wash.—Sewer.—James C. Broad, at \$1,109 for constructing sewer in alley between Dean and Mallon Aves.; Thomas Maloney for the Federal Labor Union at \$4,232, for sewer in 2nd Ave.

De Pere, Wis.—Sewer.—Thos. Connelly and Wm. Calnan, at about \$1,000 for sewers on West Side.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States.

Montgomery, Ala.—County Board of Revenue has authorized the construction of a reinforced concrete bridge over Catoma Creek to cost about \$12,000.

Hope, Ark.—County will erect five steel bridges next year. W. A. Briant, Washington, Ark., is county judge.

Malvern, Ark.—J. E. Chamberlain and W. S. Hughes have been appointed bridge commissioners to locate and superintendent construction of proposed county bridge over Ouachita River at Green's Ferry.

Los Angeles, Cal.—Board Public Works has accepted \$20,000 from the Los Angeles Ry. Co., as its share of the proposed bridge over the Los Angeles River at Main street and contract for the work will be signed at once.

Vallejo, Cal.—Residents of this place are advocating the building of a State bridge across the Carquinez straits from South Vallejo to Valley Junction. The bridge would be a suspension affair, from bluff to bluff and would be erected by the State and leased to the railway companies.

Atlanta, Ga.—Resolution is before the city council for remodeling entrances to the Forsyth street viaduct and closing under pass.

Savannah, Ga.—Seaboard Air Line Ry., E. A. Frink, bridge engineer, Portsmouth, Va., has submitted plans to U. S. War Department, for a lift bridge to replace its present structure over the river at this city.

Hume, Ill.—State Engineer A. N. Johnson, Springfield, Ill., is preparing plans for seven bridges in Hume Township.

Princeton, Ind.—County Commissioners have adopted plans for new steel bridges to be built in the county and contracts will be let at the December meeting of the board. About 30 new bridges are to be built and four or five old ones repaired.

Lawrence, Kan.—Union Pacific Ry. is reported to be considering building new bridge over the Kaw River at this place.

Bangor, Me.—Bangor Railway & Electric Co., John R. Graham, president, is reported to have made proposition to city council, for building two new spans and repairing piers of the Brewer bridge.

Takoma Park, Md., (P. O. Takoma Park, D. C.)—Town has rejected all bids for constructing reinforced concrete bridge over Sligo Creek. Bridge is to be 275 ft. long, with 16 ft. roadway, and \$10,000 is available for its construction. Ben G. Davis, Town Clerk.

Port Huron, Mich.—Grand Trunk Ry. T. T. Irving, Resident Engineer, Detroit, Mich., according to advices from this place, will shortly take up matter of building its overhead bridge at Military St.

Joplin, Mo.—Work is to be started at once on a steel viaduct at 3rd st. Construction of the 38 concrete foundations will be done by day labor, under supervision of City Engineer Hodgdon.

Rochester, N. Y.—Bridge Department, State Engineer's Office, Albany, N. Y., has completed plans for bridge over the barge canal at Allen St., this city.

Cleveland, O.—Cleveland Terminal & Valley R. R. Co. has applied for permission to construct a lift bridge to replace the present bridge over the Cuyahoga River.

Cleveland, O.—Bids are to be asked at once for the construction of the Harvard-

Denison bridge, for which a \$450,000 bond issue has been voted. R. W. Hoffman is City Engineer.

Dayton, O.—City Engineer Cellarius has plans under way for building new bridge at Stewart St.

Pittsburg, Pa.—City has voted to issue \$4,430,000 of bonds for public improvements. The bridge work that can be begun at once under this bond issue is as follows: Erection of a new bridge to the North Side at the Point, \$1,000,000; new Larimer Ave. bridge, \$175,000; bridge across Negley run hollow from Meadow street, \$65,000. A. B. Shepherd is Director Public Works.

Reading, Pa.—City officials and officials of Philadelphia & Reading Ry. have been in conference regarding the construction of a bridge over the company's Lebanon Valley tracks at Tulpehocken St.

Austin, Tex.—Following bids were received Nov. 5 by County Commissioners for constructing bridge over Colorado River at Congress Ave.: Missouri Valley Bridge Co., Leavenworth, Kan., \$245,615; Robert Storrie, Fort Worth, \$186,462; Geisel Construction Co., St. Louis, \$188,126; William P. Carmichael & Co., St. Louis, \$176,495; Midland Bridge Co., Kansas City, \$286,395.

Salt Lake City, Utah.—Council Finance Committee has recommended that city proceed at once with the erection of a new bridge over the Jordan River to replace the "white bridge" on North Temple St., at a cost of \$8,000. L. C. Kelsey is City Engineer.

Milwaukee, Wis.—Board Public Works has estimated cost of reinforcing and repairing 16th St. viaduct at \$65,000. C. J. Roetsch is City Engineer.

Railroads.

Items Arranged Alphabetically by States.

Globe, Ariz.—Gila Valley, Globe & Northern Ry., J. H. McClure, Engineer M. of W., Tucson, Ariz., is to be extended six miles to Miami.

Little Rock, Ark.—Meto Valley Ry. Co. has been incorporated, and proposes to build a railroad from McCreanor, on the Rock Island road, a station a few miles east of Lonoke, a distance of 16 miles in a southerly direction in Lonoke County. The incorporators are E. C. Murray, S. M. Savage, C. P. Harnwell, E. S. Jett and R. J. Stroud. The road is to be built for the purpose of developing the timber lands in the southern portion of Lonoke County.

Pine Bluff, Ark.—Arkansas, Louisiana & Gulf Ry., now in operation between Crossett, Ark., and Monroe, La., is to be extended north with a terminus either at Pine Bluff or Little Rock. E. T. Bond, Bostrop, La., is Chief Engineer.

Sedgwick, Ark.—Survey is reported made for the extension of the Cache Valley R. R. from Light, Ark., to Paragould, Ark., 18 miles. The road is built from Sedgwick to Light, Ark., 12 miles. It is also contemplated to build from Sedgwick to Newport, Ark., 40 miles. R. F. Schatzman is Chief Engineer at Sedgwick, Ark.

Plant City, Fla.—Surveys have been completed and necessary money appropriated for an extension of the Plant City, Arcadia & Gulf Ry., through to Arcadia. Construction work is to be started at once, it is said. P. O. Knight, Tampa, Fla., is President.

Albany, Ga.—Georgia, Southwestern & Gulf R. R. Co. has filed a mortgage for \$4,000,000 of stock and bonds for a similar amount and proposes to use the funds for building and equipping a railroad. The company is incorporated under the laws of Georgia and proposes to build a railroad from Dawson and Albany, in a southwesterly direction, going through Terrell, Calhoun, Dougherty, Baker, Miller and Decatur in Georgia and through Jackson, Calhoun and Washington Counties, in Florida, to Dyers Point, a distance of 157 miles. It is also stated that it is the intention of the company to build branch lines and acquire others by purchase, making a total mileage of about 200 miles.

Iowa City, Ia.—Chicago, Rock Island & Pacific Ry., Q. M. Brown, District Engineer, Davenport, Ia., may construct \$60,000 subway here on Gilbert St.

Aurora, Ill.—Chicago, Burlington & Quincy R. R. is said to be considering double tracking its line from Aurora to Savanna, a distance of 107 miles.

Springfield, Ill.—Chicago, Peoria & St. Louis Ry., M. D. Schaft, Superintendent, Springfield, has purchased gravel pit near Peoria and will do considerable reballasting work.

Columbia, Mo.—Company is to be organized to build a railroad from Columbia to

connect with the Chicago & Alton and the Wabash. The proposed length is 31 miles and the road will open up 200,000 acres of coal land, about 18 miles of right of way from Columbia has been secured. The road is being promoted by State Senator B. M. Anderson.

Tucumcari, N. Mex.—Local Business Men's League is considering a proposal to pay a bonus of \$10,000 for the construction of a railroad from Texico to Tucumcari.

New York, N. Y.—New York, New Haven & Hartford R. R. which controls the New York, Westchester & Boston Ry. Co., 37 Wall St., New York, has applied to State Public Service Commission for certificate of necessity to enable it to build the latter road. Considerable construction has already been done.

Cleveland, O.—Construction of belt line railway passing through East Cleveland and Collinwood is prepared. Ben Hopkins is Engineer.

Dayton, O.—Dayton, Lebanon & Cincinnati R. R. is securing entrance to this city from the south. The road will connect Dayton and Cincinnati. Frank Brandon, Lebanon, O., is President.

Beaver, Okla.—Reports from this place state that the contract has been signed for the construction of the Beaver Valley & Northwestern R. R., from Gage, in Ellis County, via Beaver City to Hooker, in Texas County, a distance of 100 miles. The road was chartered last July to build from Oklahoma City to La Junta, Colo., and the line from Gage to Hooker is to be the first construction done. The company is capitalized at \$4,000,000. It was organized and the preliminary work financed by capitalists of Wichita, Kan., and Northwestern Oklahoma. J. W. Webb of Beaver is President.

Clinton, Okla.—Work is to be started here this month on the construction of Clinton & Colorado Springs R. R., according to a statement by Col. C. C. Goodman, Fort Smith, Ark., the chief promoter of the project. The first section will be to Butler, northwest.

Kingfisher, Okla.—Residents of this city have raised bonus of \$15,000 and are securing right of way for five miles northwest and five miles northeast of city, as an inducement for building a northwest line of railroad through the city.

Georgetown, S. C.—Advices from the city state that Capt. Samuel Sparks is considering building either an electrical or steam railway between True Blue and Pawley's Island, six miles distant.

Austin, Tex.—Gulf, Texas & Western Ry. Co. has been chartered and proposes to build a railroad from Burrs Ferry, on the Sabine River, in Newton County, to Benjamin, Knox County, a distance of approximately 500 miles, according to Ben B. Cain, Tyler, Tex., a director of the road, construction work is to be started this year.

Ochiltree, Tex.—Enid, Ochiltree & Southwestern R. R. Co. has been chartered and proposes to build a 265 mile line. The first section will be built between Dalhart and Ochiltree, 101 miles. George M. Perry, County Judge, will probably be president of the road.

San Antonio, Tex.—Business Men's Club of this city has endorsed proposition of L. F. Edwards, St. Louis, Mo., in building a railroad from San Antonio and Brownsville, and is raising \$100,000 bonus.

San Antonio, Tex.—Contract for constructing portion of Artesian Belt R. R. controlled by Dr. Charles F. Simmons, San Antonio, has been let to J. F. Burns Construction Co., Devine, Tex. The road will be completed from Macdonia south to New Artesia, about 40 miles. From the latter point it will be continued to Simmons City, in Live Oak County, between 20 and 30 miles. Surveys for the latter portion of the line are to be made, and arrangements will be made for a further extension toward the Rio Grande. William Bradburn, San Antonio, Tex., is Chief Engineer.

Norfolk, Va.—Lynnhaven Construction Terminal Corporation has been chartered and proposes to construct a railroad through Nonsemond and Princess Ann Counties from Norfolk. Alvah H. Martin is President.

Marquette, Wash.—Ironwood & Hurley Traction system which extends from Jesseville through Ironwood to Hurley and Gile, Wis., a distance of five miles, is to be extended to Bessemer, the County seat of Gogebic County, increasing its length by five miles.

Walla Walla, Wash.—Right of way is being secured for a railroad from this city to Wallula, one way and to Dayton on the other, a total distance of 70 miles. The project is being promoted by Dr. N. G. Blalock and John H. Morrow, Waitsburg, Wash.

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U. S. ENGINEER OFFICE, WILMINGTON, N. C., October 20, 1908. Sealed proposals for constructing a steel draw-span highway bridge with pile and concrete foundations, on Core Creek, near Beaufort, N. C., will be received at this office until 12 noon, standard time, November 20, 1908, and then publicly opened. Information furnished on application. EARL I. BROWN, Captain Engineers.

U. S. ENGINEER OFFICE, CHICAGO, Ill., Nov. 2, 1908. Sealed proposals for pile pier construction and removal of old pier in Michigan City Harbor, Ind., will be received at this office until 10 a. m., Dec. 12, 1908, and then publicly opened. Information on application. THOS. H. REES, Mayor, Engineers.

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TILE DRAINS.

Peoria, Illinois.

Sealed bids will be received by the Commissioners of the Hallock & Medina Drainage District of Peoria County, Illinois, at the office of W. S. Kellogg, Attorney, 100 S. Jefferson Ave., Peoria, Illinois, until two o'clock p. m. the 11th day of December, A. D. 1908, for furnishing and laying 31,757 feet of drain tile ranging in size from 8-inch to 30-inch diameter.

Bids must be accompanied by cash or certified check equal to 10 per cent of the amount of the bid. Contractor will be required to file bond in the amount of 50 per cent of the estimated cost of the work. Plans and specifications can be seen at the office of the Harman Engineering Co., 120 Fredonia Ave., Peoria, Illinois. Copy of specifications and form of bid may be procured by application to the Engineer. Payments will be made in cash on monthly estimates. Works to be completed on or before the first day of November, A. D. 1909.

Commissioners reserve the right to reject any and all bids.

ZEALY M. HOLMES,
ALONZO M. ROOT,
IRVING J. CASE,

Commissioners.

HARMAN ENGINEERING CO., Engineers, 120 Fredonia Ave., Peoria, Ill.

SEWER SYSTEM.

Memphis, Tennessee.

Bids will be received at the office of J. A. Omberg, Jr., 608 and 610 Goodwyn Institute, Memphis, Tenn., until noon, 25th of November, 1908, for the construction of a system of sanitary sewers.

The sewer system comprises about 13,000 ft. of sewers from 6-in. to 15-in. diameter.

Bids must be accompanied by certified check for \$250, made payable to City of Binghamton.

Right is reserved to reject any or all bids.

Work will be paid in 5 per cent bonds of Town of Binghamton.

J. A. OMBERG, Jr., Engineer.

WATER WORKS AND SEWERS.

Covington, Ga.

Sealed proposals will be received by the Chairman and Board of Commissioners of the City of Covington, Ga., until 3 p. m., December 2, 1908, for the construction of water and sewerage systems in and for the city of Covington, Ga., and furnishing all necessary materials for same.

Waterworks system will embrace approximately 400 tons of 6 to 10-in. cast iron pipe, with necessary valves, hydrants, etc., one 15x119 stand pipe, two compound pumping engines, one turbine pump and motor, brick pumping station, settling basin and clear water basin.

Sewerage system will embrace approximately 5 miles of vitrified clay pipe sewers from 6 to 15 ins. with all necessary manholes, flush tanks, etc.

Plans, profiles, etc., may be seen at the office of the chairman of the Board of Commissioners and copies of the specifications, forms, etc., may be obtained from the engineers or chairman.

The right is reserved to reject any or all bids.

C. C. BROOKS,

Chairman Board of Commissioners.

J. B. MCCRARY & CO., Engineers,
Empire Bldg., Atlanta, Ga.

STEEL WORK.

Madison, Wisconsin.

The Wisconsin Capitol Commission invite proposals for furnishing and erecting the Steel Work of the South Wing and Central Portion of the State Capitol now building at Madison, Wisconsin. The same is to be executed according to the plans and specifications and under the supervision of Geo. B. Post & Sons, Architects, 247 5th Ave., New York.

All bids must be on blanks furnished and accompanied by a certified check of 5 per cent of their amount, made payable to the order of the Capitol Commission. This shall be forfeited in case the contract is awarded to the maker and he fails within ten days to execute contract and furnish bond as provided for in the specifications.

All proposals must be enclosed in properly endorsed envelopes and delivered to the undersigned on or before noon of Friday, December 18, 1908.

LEW F. PORTER,

Secretary of Capitol Commission.

PUMPING ENGINES.

Augusta, Georgia.

Sealed proposals will be received by the Water Work Committee of the City Council of Augusta, Ga., until 4 p. m. (Eastern time) Tuesday, November 24th, 1908, for furnishing and erecting at Augusta, Ga., a pumping engine of six (6) million gallons daily capacity and a steam plant of four hundred and fifty (450) horsepower capacity.

The city reserves the right to reject any or all proposals.

Specifications can be had by applying to this office.

NISBET WINGFIELD,
City Engineer.

STEEL TANK AND TOWER.

Gridley, California.

Sealed bids for erecting a steel tank and tower for the City of Gridley, Butte County, California, will be received at the office of the City Clerk of Gridley up to the hour of 12 m., on Monday, the 14th day of December, 1908. Printed copies of the specifications for the above tank and tower, printed forms for proposals and printed copies of the complete advertisement may be obtained on application to the office of Engineering-Contracting, 355 Dearborn street, Chicago. Each bid must be accompanied by a certified check payable to the President of the Board of Trustees of the City of Gridley, to at least 5 per cent of the amount bid. The Board reserves the right to reject any and all bids. All bids submitted must be according to the statutes of the State of California.

F. G. MOESCH, City Clerk.

FORT MYER, VA., OCTOBER 20, 1908.
Sealed proposals in triplicate will be received at the office of the Constructing Quartermaster, until 11 a. m., November 18, 1908, and then opened, for the construction of fences for corrals for artillery stables at Fort Myer, Va. Certified check or Surety Company's guarantee for 10 per cent of the amount must accompany each bid. Plans and specifications will be furnished upon application. The Government reserves the right to reject any or all bids. Proposals and envelopes should be marked "Proposals for construction of corral fences," and addressed to Captain B. B. HYER, Constructing Quartermaster.

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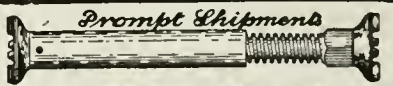
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CAST IRON PIPE AND SPECIAL CASTINGS.

Amsterdam, N. Y.

Sealed proposals for furnishing cast-iron water pipe and special castings will be received by the Board of Water Commissioners of the City of Amsterdam, N. Y., at their office in the Farmers' Bank Building, until 8 o'clock p. m., of November 24th, 1908, at which hour said proposals shall be opened and read in the presence of said Water Commissioners.

All proposals shall be enclosed in a sealed envelope addressed to Charles C. Yund, President of the Board of Water Commissioners, Amsterdam, N. Y., and across the end of such envelope and upon the face side of same, the words "Proposal for Cast-Iron Pipe for Hanns Creek Conduit No. 2" shall be written.

Each proposal shall contain a certified check or a New York or Boston draft in the amount of \$10,000 (ten thousand dollars) payable to the order of John J. Turner, the Treasurer of the Water Commissioners, Amsterdam, N. Y., as a guarantee that the bidder will enter into contract in case of award to him, or in case of his failure so to do, then said amount shall be absolutely forfeited to said Water Commissioners.

No checks or drafts thus presented to the Board of Water Commissioners, shall be returned to the bidders until after the award and signing of the contract and the furnishing of satisfactory sureties and bond for faithful performance by the successful proposer. No bids shall be withdrawn after they have been opened by the Water Commissioners.

The Board of Water Commissioners expressly reserves the right to reject any or all proposals if such action appears to them to be for the best interests of the city. Specifications and proposal sheet for this contract may be procured by intending bidders, by application to James R. Snell, Superintendent of the Water Works, after November 12th, 1908.

Approximate Quantities.

The approximate quantities in net tons are as follows:

30-inch straight piping.....	3,538
24-inch straight piping.....	3,844
Smaller sizes, straight piping.....	16½
30-inch special castings.....	25
24-inch special castings.....	20
30-inch inspection castings.....	16
24-inch inspection castings.....	20

CHARLES C. YUND,

President of the Board of Water Commissioners, Amsterdam, N. Y.

FRANK H. M'CONNELL,

Secretary of the Board of Water Commissioners, Amsterdam, N. Y.

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From La Ligua to Copiapo, an extension of approximately 680 kilometers— all within the Republic of Chile.

Proposals should be addressed to the Minister of Public Works, Santiago, Chile, or to the Legation of Chile, Washington, D. C.

The Legation at Washington will furnish all particulars to contractors desiring to bid upon the work. The date for opening the bids by the Minister of Public Works in Santiago, Chile, is Feb. 1, 1909, for the La Ligua-Copiapo Railway.

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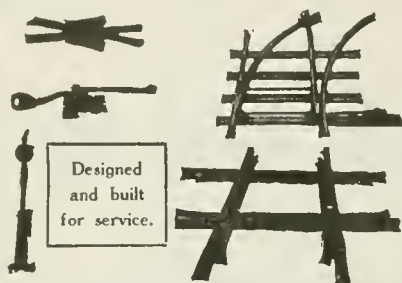
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 Two No. 5 Smith's on Skids, with Engine.
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 Two No. 17 Cube on Trucks with Engine and Boiler.
 Two No. 3 Foote Street Machines complete.

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Old Colony Bldg. Chicago, Ill.**ASSIGNEE'S SALE****MONDAY, NOVEMBER 23**

On the Grounds at California, O., Cincinnati, O., New Water Works, all the Equipments of the **Keeling & Ridge Co.**, Located at California, O., will be Sold at Public Auction, in Separate Lots.

THIS contractor's outfit represents an outlay of about two hundred thousand dollars (\$200,000). The sale will positively take place on Monday, Nov. 23, at 9:30, and continue until everything is sold, regardless of the weather. There is such a vast stock, that there will be many wonderful bargains. The sale will be conducted in a strictly business-like manner, everything warranted to be exactly as represented and fair trial given to purchasers of the horses and mules, which we estimate the aggregate value at twenty thousand dollars (\$20,000). There are hundreds of wagons and harness of all kinds, plows, scrapers, steam shovels, Jackson conveyors, large and small locomotive cranes, several hoisting engines, 3 13-ton Kelly Springfield road rollers, concrete mixers, road machines, 100,000 feet of lumber, and a complete outfit of contractor's supplies.

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J. O. WOODWARD, Auctioneer, 43 Wiggins Blk., Cincinnati, O.

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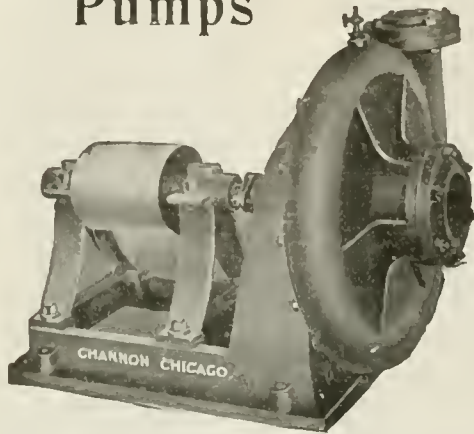
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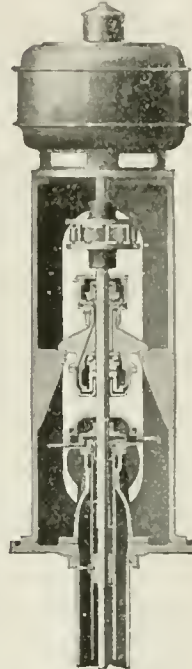
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The Blackwell's Island Bridge Blunder.

For about five years work has been going on in the city of New York in building the Blackwell's Island bridge over the East river. This is a large cantilever bridge with two shore spans, an island span, and two river spans, the latter being 984 and 1,182 ft. The bridge is about completed, the total cost of the structure

for lands, materials and work will aggregate more than \$23,000,000.

After the Quebec bridge failure, some question arose as to the strength of the Blackwell's Island bridge as both were cantilevers and the cross section of the bottom chords were somewhat similar. The question was discussed in the daily papers and in the technical press with the result that the comptroller of the city of New York asked that an investigation as to the strength of the bridge be made by experts. The firm of Boller & Hodge and Prof. Wm. H. Burr were separately engaged for this purpose, and their reports have been made public.

The gist of these reports is that *the bridge will not carry the live loads called for by the plan, specifications and contract*, although it is safe for some loads. According to the original contract made for the steel superstructure of the bridge, the city contracted for one thing and got another, as indicated below:

What the City

Contracted For—

1. A bridge to carry, according to Article 37 of the specifications, a uniform live load of 6,300 lbs. per lin. ft., or a congested load of 12,600 lbs. When changes were made the uniform live load was increased to 8,000 lbs. per lin. ft. and the congested load to 16,000 lbs.

2. A steel superstructure to weigh approximately 84,300,000 lbs.

3. A steel superstructure to cost approximately \$5,143,000.

It is thus seen that the city of New York is getting a much more expensive bridge than at first contemplated, yet a bridge that at present has but one-third of the carrying capacity for which a contract was made.

The bridge has been pronounced "safe," if not heavily loaded, and statement has been made that it need not be loaded as originally contemplated. Let us emphasize the fact that it is not germane to the question whether the city at present needs a bridge that has a carrying capacity of from 6,000 to 8,000 lbs. per lin. ft., or whether the elevated tracks on the bridge

What the

City Got—

1. A bridge that will carry a uniform live load of only 5,800 lbs. per lin. ft., of truss provided 1,000 lbs. per lin. ft. of steel now in the bridge be taken down. The bridge as it stands cannot carry more than 1/3 of the live load specified, but if 1,000 lbs. of dead weight is taken off the structure it will carry about 1/2 the specified load.

2. A steel superstructure weighing about 105,152,010 lbs., or an increase of about 25 per cent.

3. A steel superstructure costing approximately \$6,388,000, or an increase of about 25 per cent.

will be used or not. The fact is that a contract was made for a bridge to be constructed and completed according to the plans and specifications, and the taxpayers of the city have a right to demand that such a bridge be delivered to the city.

Where does the blame lie for not delivering such a bridge? By reading the specifications and contract made between the Bridge Department and the contractor the blame is easily fixed. Article C of the contract reads:

"The contractor will, for the price or prices herein agreed upon and determined, furnish all the material, labor * * * necessary or proper for the purpose and in a good, substantial and workmanlike manner, according to the specifications and plans and to the satisfaction of the engineer and of the commissioner, construct and complete the steel superstructure of the Blackwell's Island bridge."

Article G G provides for the prices per pound of the various kinds of steel to be furnished.

Section 3 of the specifications says: "All parts of the structure shall be built in accordance with the detail and working drawings which shall be prepared by the contractor, subject to the specifications and the general plans furnished by the Department of Bridges."

These clauses show a contractor's responsibility, as well as the responsibility of the Department of Bridges.

In considering the reports of the experts engaged by the Bridge Department, it must be remembered that these reports are made in answer to whether the bridge was safe or not, and the responsibility for overloading the bridge with dead load was not touched upon. Professional etiquette and the limitations put upon the investigation forbade these engineers from finding fault with those who had employed them. An investigating committee would have dealt with the phase of the question in quite a different manner.

Engineering-Contracting believes that the form of contract under which this work was let is wrong. Why should the city of New York require the contractor to design all details for any important bridge? The contractor makes the city pay handsomely for this designing work, although indirectly. There is no reason why the designing should not have been done by the Bridge Department. Working under a price per pound for the steel and permitted to work out his own designs, a contractor has every incentive to load a bridge up with all the steel possible.

The Blackwell's Island bridge now weighs more than 35,000 lbs. per lin. ft., but has a live load carrying capacity of 4,000 lbs. What more need be said of such design?

A study of the specifications shows clearly that these specifications were originally drawn for a lump sum contract, or copied from such a contract, instead of being

drawn for a pound price contract; for in many places where a dimension is specified, only a minimum is prescribed, instead of prescribing *both* a maximum and a minimum as should be done under a unit price form of contract where the contractor makes the working drawings. Without burdening our readers with details, we may say that sections 3, 55, 65 and 88 show clearly the nature of this blunder.

These specifications when applied to a pound price contract would require the most careful and prompt checking of the contractor's working drawings in order to prevent any overloading of the bridge, intentional or otherwise. Apparently the Bridge Department failed miserably in checking and changing the contractor's drawings until the Quebec bridge disaster awoke the public to a possibility of its repetition. But then it was too late to make a good bridge out of a poor one, and to give to the city of New York what it had originally bargained for.

Among minor, yet important, oversights, it may be mentioned that no provision is made for a snow load on this bridge. Prof. Burr, in his report, says that it would have been advisable to have made suitable provision for this class of loading, and then adds: "At the same time, if the usual street cleaning removal of snow from the bridge is promptly made, it is clear that there is practically no possibility of snow load and even the regular live load concurring."

We differ radically from this view, and believe that the snow load can concur with a decided congestion of the traffic, and indeed that the snow may itself cause such a congestion.

Inasmuch as the reports on the bridge state that some of the members are overstressed, and that overstresses may occur in other members, there has been a clamor from some engineers that actual tests be made of these members. Several suggestions have been made as to the methods of making such tests. If desired, the city can easily have this done, as section 31 of the specifications provides: "Full size parts of the structure may be tested at the option of the engineer."

An independent investigation of the Blackwell's Island Bridge blunders should be made, and the following questions put the Bridge Department of New York city.

1. After calculating stresses from the original assumed loads were recalculations made?

2. If so, when and by whom?

3. Did you not base your specifications on a lump sum contract, and subsequently change to a unit price contract?

4. Or did you originally contemplate making your own working drawings, and then abandon the idea in order to rush through a contract before a change of administration?

5. Is it not true that three administra-

tions of the bridge department have had charge of the Blackwell's Island bridge?

6. Did not one administration draw the contract and specifications and award the contract?

7. Did not the second administration approve the detail and working drawings made by the contractors, which drawings call for an excessive weight of steel.

8. Did not the present administration allow the bridge to be erected from these drawings and plans when they could have prevented it, and could have seen to it that the city got a bridge that would carry the stipulated loads?

9. Is it not true that the contractor's drawings were not checked by any official of the bridge department to learn the exact loading and stresses until in the spring of 1908, when the steel superstructure was practically complete, and just about the time that the "New York Tribune" demanded that an investigation be made as to the strength of the bridge?

The following questions might be asked Prof. Burr:

In the third conclusion of your report you state: "The various members of the structure possess the full sections required by the unit stresses and the working plans, and the shipping weights correspond to those sections as well as to the computed weights."

Is it not a fact that this refers to the drawings gotten up by the contractor? Was not the overloading of the bridge, therefore, done by the contractor, with the acquiescence of the bridge department?

Is not this statement made in your third conclusion apt to mislead anyone who does not know that the contractor made the working drawings?

In your sixth conclusion you state that stresses on the main trusses members are higher than prescribed as permissible in the specifications. If so, who blundered in not making the members strong enough?

The Blackwell's Island Bridge, including lands, has cost the city more than \$23,000,000, or double the original estimate.

This fact alone is sufficient reason for an exhaustive investigation. The blunders now disclosed remove every wavering doubt as to whether it will pay to investigate the Bridge Department. There are many who will declare that it is poor policy to send good money after bad by undertaking an investigation. But, in truth, there is no prospect that an inefficient city department will ever become efficient unless subject to the most thorough overhauling by a competent and independent commission. Such a commission was appointed by Canada to report on the cause of the Quebec bridge disaster, and its disclosures were little short of astounding. We may expect not less astounding results to follow an equally careful examination of the methods of the Bridge Department now in charge of the Blackwell's

Island bridge. If the investigation should result merely in abolishing the pound price system of bidding on bridges whose working drawings are prepared by the contractors, it would well repay an expenditure of hundreds of thousands of dollars. However, there is no need of any great additional expense for an investigation. The costly part of it has been already made by the engineers above named. What is now needed is, first, the fixing of blame where it belongs, and, second, the development of a system that will prevent a recurrence of such costly blunders as this.

Indeed, we may go a step farther. It would well pay the city of New York to have a standing commission of engineers whose principal duty would be to inspect all the engineering departments of the city, and report to the comptroller. On such a commission there should not be placed a lot of "consulting engineers" whose time will be spent mainly in consulting their own convenience as to when they will work and how. The engineers on such a commission should devote their entire time to it. That they can effect immeasurably great economies in the engineering work done by the city cannot be doubted for a moment by anyone who is acquainted with existing conditions.

We have suggested that the commission should report to the comptroller. As a matter of fact, the comptroller's present engineering force might properly be enlarged to constitute this commission. The commission should be clothed with power to compel every city department to keep itemized costs and records of construction and maintenance upon a uniform system prescribed by the commission. Such a system would permit intelligent study of the relative economies in the construction and maintenance of pavements, bridges, and other engineering works. Under the scrutinizing eye of the commission, the various city departments would have an incentive, now largely lacking, to bring their departments to a high standard of efficiency.

The grand total of excavation on the Isthmian Canal during the month of October was 3,224,638 cu. yds., according to the Canal Record, the highest record for the rainy-season excavation. All of this except 111,075 cu. yds. was taken from the Canal prism. This is 65,752 cu. yds. more than the record for September, and 255,632 cu. yds. less than the highest record, that of March, 1908. There were 27 working days in October, two more than in September and one more than in March. Of the grand total for October, 1,271,136 cu. yds. were taken out by dredges, and the remainder was dry excavation. The average rainfall for October for the territory in which excavation is in progress was 10.51 in., as compared with 9.72 in. in September.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

The Early Cement Makers.*

[The personalities of the men who have made the iron and steel industry the immense thing that it is have been made familiar by scores of writers. Next to iron and steel, hydraulic cement is today perhaps the most important artificial building material. In a general way we recall the names of the pioneers, Aspdin, Pasley and a few others, in the cement industry, but few of us know definitely but little of these men and their work, and almost none of us can call by name the more recent and more scientific leaders who have made hydraulic cement the close rival if not the equal of iron and steel in usefulness to mankind. It is with particular interest, therefore, that we have read the address whose title heads this article and have reprinted it here. We believe that many of our engineer and contractor readers will have pleasure and profit in taking the same excursion from the terse, matter of fact citation of methods and costs which commonly occupy our space into the field of history and reminiscence opened by Mr. Lesley in his address.—Editors.]

When you read and hear of what some of the pioneers in the cement industry did in the early days in this country and in Europe, you will realize why this great industry forged ahead. The old story of the Eddystone light-house and John Pasley's investigations on Portland cement and hydraulic limes in England is familiar to all of us, but it is interesting to know that while these investigations were being carried on in England, France had Vicat, the great chemist, struggling to produce an artificial hydraulic cement to answer the purpose of Pasley's hydraulic lime in England. This he finally accomplished and in a works in France today a light burned Portland cement is being made under the identical prescription that Vicat gave them 75 years ago.

In England the discovery of hydraulic lime led to an ardent desire to find out more about cement and finally a material was found to which when calcined the name of Roman cement was given and which was the pioneer cement in England. The discovery of the material or Septaria—Sheppey and Harwich stones—is an old story and one which I will not go into at this time, but it led to the making of the

first cement in England, the Roman cement.

Now while Roman cement had been discovered and was being made, there were others who were trying to make what Pasley described as cement of hydraulic character. Frost, in England, was trying certain proportions of limes, clays and so forth, but which gave a material neither fish nor fowl. However, he finally took out a patent in 1822 and called his product British cement, which was something like his own name, "a frost." Subsequently, he took out a second patent and shortly after started works at Swanscombe. He carried on this business for some years, but it was finally acquired by John Bazley White, who was at that time making a hydraulic plaster. Frost's patent and the John Bazley White discoveries in Roman cement formed one side of the great division in the English cement industry in the early days.

Now along in 1824 our old Aspdin appears on the scene with a patent for "A Method of Making Lime," this being his second patent, the first covering specifications for "An Improvement in the Modes of Producing An Artificial Stone," which patent you can read any place you please and at any time you please, and which was practically the first scientific description of an artificial Portland cement. In his early experiments he used hard limestone found near his plant and struggled along for some time trying to make something out of these limestones and clays which he thought would be a hydraulic cement. At

*This pioneer and inventor of cement is still enjoying life at the advanced age of ninety-eight, and is a magistrate and one of the most respected residents of the town of Gravesend, England. He is in active work as the head of the firm of I. C. Johnson & Co., who own a quarter of a mile of cement works on the Tyne from which they send cement to all parts of the world. Isaac Charles Johnson was born in the year 1810, when George III was king and Jefferson was president, and when Napoleon was at the zenith of his power. At that time the whole of the United States had only seven millions of people. He is probably the most "chipper" old gentleman in existence, and bids fair to rival that "very old man," Thomas Parr. He is an expert cyclist, although he only took to the recreation when he was eighty-seven. He is an extensive reader, and has written pamphlets on all kinds of subjects. He is a photographer and an earnest teetotaler, and can preach a sermon and make a speech as well as most men. He was born of poor parents, and when a boy was so delicate that he was not expected to reach manhood. With a very slight education he began life as an office boy in a bookseller's shop off the Strand. He was then apprenticed to a builder, and after serving his time, worked as a "journeyman" on five dollars a week. Then he became an architect, and a house which he built in the Elizabethan style is still standing at Swanscourt in Kent. It was at this time that he first invented Portland cement.

this time he didn't have quite the idea of a Portland cement, but he ultimately got it by burning his hard mountain limestone clays at a higher temperature.

At this period of the industry (in 1845) there were two strong factions at work in England. On the one side was John Bazley White, who was one of the greatest men England ever produced, who was making Roman and Frost's cement, the latter a lightly calcined artificial cement. On the other side was Aspdin making Portland cement, and, who, after securing some financial backing, came down to the Thames district and used the soft clays and chalks found there for the manufacture of his product and ultimately formed the firm of Robbins, Aspdin & Co.

About this time a man by the name of I. C. Johnson,† who was in the White concern at Swanscombe, was greatly interested in finding out what Aspdin was doing. Owing to the great secrecy with which Aspdin surrounded the making of his material, Johnson had considerable difficulty in learning anything about Aspdin's process. It is said that his plant was surrounded by a wall 20 ft. high and there was no access to the works except through the office. Johnson knew that Aspdin had all sorts of mysterious trays containing all kinds of chemicals and compounds, but he could not get at them. He finally secured some of the cement in common use and sent it to one of the leading chemists in England for analysis, and that chemist reported that the cement contained 60 per cent of phosphate of lime. You can readily imagine that about this time Mr. Johnson got very busy. He spent most of the succeeding weeks in neighboring bone yards and bought bones of every variety and description, and then started in to discover the process of making Portland cement. He calcined the bones in the open air at his little plant, and the stench was so great that his works were suppressed, but he didn't produce Portland cement. He then started on the theory that natural cement was the key to the situation and finally did exactly—and this is the interesting part of it, and what I want you to bear in mind—what D. O. Saylor did in this country, started to "pound it out." He took chalk and clay in different proportions until he got something that looked pretty satisfactory, but when mixed with water in the shape of pats or briquettes, or whatever you choose to call them, they expanded and cracked. His theory was that of Pasley's, that cement should heat in setting. This of course was perfectly true of hydraulic limes, materials in which Pasley dealt, but not of Portland cement. So he struggled along until one day, quite by accident, he found some clinker or hard particles which he had been discarding, and upon pulverizing that and adding it to his material he found that he had discovered Portland cement, just as Aspdin had.

Another interesting fact is that in 1851,

*An address delivered by Robert W. Lesley, Assoc. M. Am. Soc. C. E., before the Lehigh Valley Section of the American Chemical Society at Easton, Pa., May 29, 1908.

when the first of the great expositions was held, there were shown samples of Portland cement and Pasley—who was the “granddaddy” of all the ideas concerning hydraulic limes—for the first time knew that Aspdin had taken out a patent in 1824 of what he himself had written about in 1820.

Engineering records in England are full of experiments of natural and Portland cements in the early fifties. The great cement war that had been going on between the exponents of these two kinds of cement ended, as you know, in a victory for Portland cement. Natural cement was eventually driven to the wall and the Portland cement business became a thriving industry in Europe.

You must not fail to realize what these early pioneers in England had to overcome and the great difficulties that beset them on every side. They had no precedents to guide them; no Newberry formula; no Le Chatelier formula or none of those interesting things with which you gentlemen are now so familiar. The difficulties and obstacles conquered by those early pioneers is a glowing tribute to the early manufacturers of Portland cement.

Over in this country the cement industry was started under somewhat similar conditions. The beginning of the Portland cement industry here was in the simplest way. We had built up a large natural cement industry because “necessity is the mother of invention,” and wherever there was a canal or waterway to be built there had to be used an hydraulic mortar. The first large public works built in this country were the canals, and the most necessary thing to build a canal was mortar that would hold the stones together at the locks or walls under water. Consequently wherever canals were to be built there was a search for cement rocks, and all the earliest works in this country were established on the lines of the canals. Thus, on the Chesapeake and Ohio Canal were the Cumberland and Round Top Works; on the Lehigh Canal the works at Siegfrieds and Coplay, Pa.; on the Richmond and Allegheny Canal the works at Balcony Falls, Va.; on the Delaware and Hudson Canal the large group of works at Rosendale and Kingston, and on the Falls of the Ohio Canal, the large aggregation of works about Louisville. From this fact grew the early package used in shipping cement in this country, the barrel, which was the package best adapted to water transportation, and it took many years to overcome the prejudice against any other form of package and to substitute the paper or duck bag for the barrel.

I was with Mr. Saylor in the early days. He started ahead of me and gave me almost my first job in the cement business. Mr. Saylor, who was a man of indomitable energy and great ability, made up his mind in the early seventies that he could make Portland cement in this country, and

his first experiments are most interesting. But while he was working away there were others who had the same thought in mind. Now I want to say a few words about Saylor and his associates, which will bring you very near home. They were a great triumvirate. There was Saylor, a farmer's boy and a splendid man; Rehrig, who was the Prothonotary of the courts of Allentown, a very dignified and conservative man; Wooliver, a politician. These three men started in a little house on Sixth St., Allentown, where Rehrig lived, and where they spent night after night burning in a kitchen stove the blue rocks which they brought down from the Lehigh district. They succeeded in producing at like temperatures a material which, when burned, made a natural cement. This, by the way, was the foundation of the Coplay Cement Co. Now, while Saylor was very much pleased with the cement he was making, he wanted to improve on it and gradually make a real Portland cement. He knew that by burning to incipient vitrification the rocks of his quarry he could make a cement that at short periods showed tensile strains equal to the imported Portland cement, but he found that his cement would crumble away as time went on owing to the variation in the raw material. Now about this time he associated with him John W. Eckert, who is a chemist and a graduate of Lehigh University. Eckert furnished the chemical side of the partnership. He and Saylor gradually felt their way along and finally discovered that by grinding these properly proportioned rocks into powder, as we do, and making this powder into little bricks, that they were able by burning these newly made bricks, when dry at high temperatures, to produce a Portland cement. Now that is just a brief history of what Saylor did in the face of great difficulties. He was one of the first big men in our industry and a pioneer in making our first Portland cement in this country.

While Saylor was “pounding” along in the early seventies, there was another man out in Indiana who was struggling along on similar lines and with the same ends in view. This was Thomas Millen, and I am now going to read to you a letter written by one of his sons, which I am sure you will find interesting, giving an account of his father's early efforts:

“In 1871, Thomas Millen and his two sons were engaged in the manufacture of cement sewer pipe, artificial stone sidewalks, etc., at South Bend, Ind. The first car of Portland cement brought into that city by them cost \$9.12 per barrel. They often talked about the nature of Portland cement and what it was made from, but could not find out until one day Mr. D. Millen was sitting in the office when a man came in and said he hoped Mr. Millen would excuse him, but he saw something in the yard that made him think of home, and being asked what it was he

said that it was the pile of empty cement barrels with the old K. B. & S. labels on. He went on to say that over in England he had worked in those works all his life, and that it seemed like seeing some one from home to see those old barrels.

“In the course of the conversation he asked Mr. Millen why he did not make his own cement, as he had seen plenty of the material at South Bend. He informed Mr. Millen that the marl around the lakes at Notre Dame and the blue clay in the river bed were the materials, but did not know how the cement was made, as he had worked continuously in one department while in the employ of the K. B. & S. Co. He said he had heard that there was a book in England that told how to make cement, but did not know where it could be obtained.

“Mr. Millen wrote Henry Carey Baird & Company, of Philadelphia, in regard to the book, and after waiting several weeks they wrote, saying there was such a book and that they could get it at a cost of \$14. They were instructed by Mr. Millen to secure the book, which they did. After studying the same, Mr. Millen used to go out to the Notre Dame lakes and get two pails of the marl in his buggy and a pail of blue clay from the St. Joseph river, and bring them into the cement pipe shop, where his son Duane would make the mixture with his hands and then burn the same in a piece of sewer pipe and grind the clinker, when he was lucky enough to get any, in a coffee mill. They continued working in this manner for six months until they felt they knew all there was to know about making Portland cement. They then leased an old saw mill on the river and built one ‘large’ kiln, 12 ft. and 4 ft. in diameter, and expected to make all the Portland cement this country might need. They continued making an addition of one kiln a year until they had four kilns 6 ft. x 24 ft. They ran these works for several years until the demand was far in excess of their output; in fact the United States War Department taking all they made. At that time Mr. Millen used to make contracts with the United States Government agreeing to furnish the department with all the cement they might need for a year.

“About 1886, Mr. Millen came to the conclusion that they must make more cement. Mr. Duane Millen was sent to Warners, N. Y., where he erected a works which is now known as the Empire Portland Cement Works. They continued running the works for several years, and in 1891 they sold both works and were out of the cement business for two years, when they found a deposit of marl at Wayland, N. Y., where they erected works and are now manufacturing.”

Now that is a history of two men in this country who “pounded” out success in our industry.

Up at Rockland, Maine, where is found

the celebrated Rockland lime, the Cobbs, of the Cobb Lime Co., under almost identical methods, commenced hewing their way in the cement industry. It turned out however that the product was too costly for commercial success and their works were closed down. Out in Kalamazoo, amid the celery beds, they were also trying to make Portland cement, but the records fall short of showing any results. Up on the Hudson, Coykendall started to make cement, but it did not succeed. There was also an attempt made to make cement at Wampun, Pa., which eventually did succeed. The successes of Millen at South Bend, Ind., and of Saylor, at Copley, have already been referred to. So that out of the six works started prior to 1881, three were failures. Certainly the industry with this percentage of loss did not offer a very encouraging outlook to the investor, and the foreign Portland cement held the market exclusively.

Now I come down to what I would call the "secondary" formation, in which I would rank Navarro, Bonneville, Whittaker (though this gentleman came a little later), Dunderdale, De Smedt, Matte, Willcox, and myself. In this secondary formation there was this difference, that in a business which was producing a new article in this country where 50 per cent were failures, promotions were not a paying proposition. You simply could not get the money. Consequently, patents were necessary to enlist capital in these early days, and many of the earlier works were founded on these patents. The great difficulty in all the American enterprises seemed to be the cost of getting the raw material into powder, then into paste, then into bricks or blocks, and then into the kilns with sufficient economy. About 1884 and 1885 patents were taken out by Messrs. James M. Willcox, E. J. De Smedt, and myself for the purpose of mixing liquid hydrocarbons with the paste. In this way a slurry was made which, when compressed into balls or eggs, could be at once put into the kilns, and thus many of the intermediate steps of drying, etc., were dispensed with and much labor and money saved. As stated, in those days we all had patents and we were all great inventors. As a matter of fact we had to have the patents or we should not have had the right to show that we had a right to exist.

Contemporaneously with the discoveries that we were making at Egypt, Pa., other inventions by Matte, Navarro and Ransome brought about the rotating kiln. It was originally designed to take the crushed rock, forming it into cement by revolving the kiln. This was before the days of the full development of the rotary kiln. The result of this crushed material being put up in the kiln was that the kiln became choked up and the makers could not get the material out. Now while Eckert and I were experimenting with our cement eggs at Egypt, and other people were

making mud pies, and so forth, the very energetic, imaginative and really far-seeing Mr. Navarro, Sr., was trying all sorts of experiments with his rotating kilns, but was not making much headway. While he was working along on these experiments with his kiln, the rest of us were laughing and thinking that he was chasing a chimera—all except a Mr. P. I. Giron, who was strenuously defending the rotary kiln. That was the first great division in the industry in this country. The rotary kiln, however, finally did succeed, and it is here to stay. It was a great contribution to the cement industry, and Mr. Navarro, Mr. Maxwell and Mr. Giron and those who worked with it, deserve all the success they have achieved.

Now, a word about Mr. Giron. There is a very good story to tell you about him. In the course of his work in connection with the experiments being carried on to develop the rotary kiln, he had occasion to travel back and forth a great deal between his home and the works, and, of course, used a monthly commutation ticket. But it happened one day that Mr. Giron had left his ticket at home and didn't discover the fact until being asked for it on the train. After a fruitless search in all his pockets and considerable excitement on Mr. Giron's part, the conductor asked him his name and said that he would take him this time and punch the ticket the next time he saw him. Thereupon Mr. Giron gave the spelling of his name, Mr. P-i-g-i-r-o-n, whereupon the conductor exclaimed, "Oh, yes, Mr. Pigiron, that will be all right," and that is the name he went by for a long time.

While the Atlas people were working out their experiments with the rotary kiln and making a success of it, at our plant we were working out the secrets of the Griffin mill, and I remember one day when the whole shop had to stay away from the Allentown Fair on account of the Griffin mill running amuck. So while the Atlas people were working out the burning side of the cement question we were working out the grinding end of the problem, and others were coming in about the same time both east and west and adding their mite to the industry.

Later on in the tertiary or third group, came along the captains of industry, the men who went into the business to make money and they built better mills and added more good construction and did more to make cement cheaper than those of us who had to forge ahead our hard fought way in the earlier days.

Now a word in advance of what the fourth formation will bring forth. It will, according to up-to-date prospectuses of cement promoters, teach people to make Portland cement for 25 cts. a barrel and put a chromo on the head of every barrel as an extra. But, to be serious again, I want to say to you all—after a long period of devotion to this great industry

with which we are associated—that we have not yet made all the discoveries to be made; that we are by no means at the end of the development of our business, and that we must realize that it is not luck or accident that brings success, but the qualities possessed by the big men of virile powers and strong characteristics of days gone by, who were able to conquer the difficulties that confronted them, and it is to you men to conquer success in our industry as did those who have gone before.

Method and Cost of Constructing a Reinforced Concrete and Steel I-Beam Highway Bridge.

The use of stiff reinforcing members capable of carrying forms and centers is familiar in both building and arch bridge construction of reinforced concrete. Recently the same principle has been used by Mr. S. B. Birds, a Canadian engineer, in constructing a 30-ft. span girder bridge for a highway near Hornby, Ont. We take the following information regarding this structure from the "Canadian Engineer" of Nov. 13, 1908:

The abutment and wing walls are built of solid concrete plumb on face and splayed behind from 3 ft. thick at bottom to 18 in. thick at top. They rest upon a solid concrete foundation slab 4 ft. wide and 1 ft. thick, founded on hard pan at a depth of 3 ft. below the bed of the creek.

The reinforcement of the bridge floor consists of four 12-in. I-beams of light section 32 ft. long, resting at their ends upon a 5-in. I-beam 15 ft. long, laid along the center of the abutment walls. This 5-in. beam forms a bearing plate for the floor beams and transmits the bridge load equally over the whole length of the abutment walls. Two 1½-in. round steel rods are placed on each side of the two inner I-beams, and one similar rod on each side of the outer I-beams, these rods being placed and wired in position before the hollow beam shells are fixed.

The U-shaped beam shells are of concrete 1 in. thick, 12 in. wide and 12 in. deep, and are cast in 3-ft. lengths upon a frame of expanded metal lath wired to U-shaped steel stirrups. The beam shells were suspended from the I-beams by steel hangers bent to shape and then poured full of liquid concrete composed of fine gravel and sand, thus forming a reinforced concrete beam 12x12 in. having a steel I-beam core in addition to the 1½-in. tension rods.

After the beams were poured thin slabs of concrete 1 in. thick, 4 ft. by 2 ft., which had been cast upon a foundation of expanded metal, were placed across the bridge floor openings between the beams and bedded and jointed with cement mortar. On top of these covering slabs and across the beams were placed ½-in. round steel rods at 6 ft. centers the whole width

of the bridge floor and the whole area of the bridge covered with a slab of concrete 6 in. thick which was made to fall away to the sides to drain off storm water into the creek.

It is proposed to keep the concrete floor slab covered with a road cushion of gravel 6 in. thick.

The handrail consists of 1½-in. gas tubing tapped and screwed and set into the concrete and follows the line of the wing walls at an angle of 45° at each approach.

The detailed cost of the work was as follows:

Excavating	\$ 18
50 yards gravel at \$2.....	100
60 barrels of cement at \$2....	120
Labor at 20 cts. per hour....	240
Steel reinforcing, including galvanized steel mold for beam shells	300
Handrail	50
Lumber for abutment forms..	25
Contractor's outfit	25
Freight and hauling.....	22

Contract price.....\$900

The actual net cost of the work would be less than \$900, as this includes contractor's outfit, lumber and galvanized steel molds, which will be used on future work.

The Italian government has placed an order for 300,000 reinforced concrete ties for use on the state railways. The ties weigh about 286 lbs. and cost about \$1.20 each.

The quantity of Portland cement produced in the United States has more than doubled in the last five years, according to figures recently issued by the U. S. Geological Survey. The total production and value for these five years were as follows:

Year.	Total Production Barrels.	Value.
1903	22,342,973	\$27,713,319
1904	26,505,881	23,355,119
1905	35,246,812	33,245,867
1906	46,463,124	52,466,186
1907	48,785,930	53,992,551

During the past year the streets of Grand Rapids, Mich., on which street car tracks are laid, were sprinkled by car sprinklers at a total cost mile of \$9,2189. The street car company operates two cars, making four trips a day, and for the service the city pays 12 cts. per mile. The city also pays for the water used. Sprinkling was begun April 13 and finished Oct. 24, the total number of miles of street sprinkled being 11,771.92. The total number of gallons of water used was 29,121,400, at a cost of 1 cts. per 1,000 gallons. The cost of water per mile was \$9,0989, and the number of gallons used per mile was 2,471.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Methods and Costs of Testing for Bridge Foundations.*

BY F. H. BAINBRIDGE.†

This article is confined to bridge foundations, although much of what follows is also applicable to foundations for buildings and hydraulic structures and preliminary examination for tunnel construction.

GENERAL CONSIDERATIONS.

Two methods of testing only are effective, an open pit or well for shallow foundations and the core drill for deep foundations. Sounding with gas pipe or rods in shallow foundations and the common well drill in deep foundations are not satisfactory. Fig. 1 shows two cross-sections of a stream at the same point, the dotted line being the line of supposed ledge rock as

involved in great uncertainty, the length of the spans selected should exceed that of the apparent economical relation. The length of spans chosen may also be influenced by other than economical considerations, such as government requirements, or the liability of ice to gorge against the bridge.

Having made a tentative location of the piers, borings should be made at each pier, and in the case of pneumatic or open dredged caisson foundations, one boring should be put down at each of the four corners of the caisson.

The preliminary borings may often be dispensed with when there are well records on both sides of the river in the vicinity. These well records can almost al-

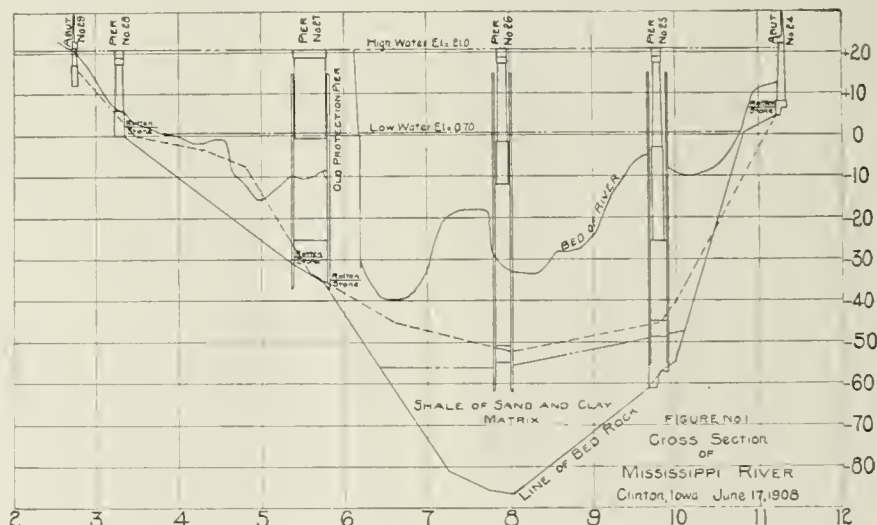


Fig. 1—Two Cross Sections of Stream at the Same Point.

determined by a well drill operating a chopping bit; and the full line, the correct location of the ledge rock, determined with a Sullivan "HN" diamond core drill.

In general two sets of borings should be made for an important bridge crossing; the first set, a number of borings on the center line of the proposed location, to determine whether the site is a favorable one, and, if favorable, to determine by approximate estimate the most economical location of the piers and the length of the spans. In a general way it may be assumed that the economical relation is reached when the cost of the substructure equals the cost of the superstructure; but inasmuch as the cost of the superstructure can be determined with considerable accuracy, while the cost of the substructure is

ways be found in the various state geological reports, which can be had at any public library in the state. In case of the borings at Pierre, South Dakota, to be described later, the well records were so good that borings to determine the length of the spans were not necessary.

In cases where pile foundations are feasible and the river bottom is firm enough to lay concrete on, no borings are necessary, the required length of piling being best determined by driving experimental piles; but where the river bottom is soft, as it is in most streams with a sluggish or reversing current, borings should be made, the softer material being taken out dry with a sawtooth bit. This is feasible in the hardest clay or the softer shales and gives a perfect knowledge of the material encountered. Unless dry cores are taken when feasible, a hard clay in every way suitable for a foundation may be overlooked and

*Reprinted from Mine and Quarry.

†Resident Engineer Chicago & Northwestern Ry., Clinton, Iowa.

provision made for carrying the foundation farther down than necessary.

VALUE OF BORINGS.

In pneumatic work an accurate set of borings with a core drill is of incalculable value. These advantages are:

1st. The final location of the caisson can be accurately determined and cut stone and timber ordered without any waste or delay waiting for material for which no provision had been made.

2d. The contractor in bidding on the work knows exactly what material is to be encountered, and will make a lower bid when there is no uncertainty. The difference in cost between handling in a caisson material which can be taken out through the blow pipe and material which must be locked out in buckets is very great.

3d. The piers can be located in the most economical position. Often a change

of clay, till, or boulders, sometimes all together in a heterogeneous mass. The extreme determined movement of the greatest glacial sheet was 1,500 miles. Boulders of granite from Canada and Minnesota were carried as far as Kansas and Missouri. One of the boulders in the river bed is therefore liable to be mistaken for ledge rock. Usually the character of the ledge rock can be learned from state surveys and samples secured from the outcrops, which are located in these surveys. When a core is obtained which can be identified as the same as ledge rock it may or may not be the actual ledge. If the core is granite or some older formation than the ledge rock, it is certain that a boulder has been reached. More recent rocks sometimes exist as pockets in earlier formations, so that a mere difference in the character of the rock from the bed rock is

Where the drill strikes first rotten or sap rock, gradually increasing in hardness until known ledge rock is reached, this is conclusive evidence of bed rock. It is best to take out very soft, rotten rock with a saw tooth bit working dry.

PIERRE, SOUTH DAKOTA, WORK.

Drill tests for the foundations of the Chicago and Northwestern Railway bridge across the Missouri River at Pierre, South Dakota, were begun in December, 1905. The drill used was a Sullivan Machinery Company's "IIN" diamond drill, operating 2-in. core bits; 1½-in. stand-pipe and 3-in. casing, both with flush joints, were used. Borings at the sites of the river piers were made from the ice. In general four holes were put down at the site of each pier. On diagonally opposite corners holes were put down to about 90 ft. below low water, and on the other two corners to 60 ft. below low water. Thirty-three holes in all were put down, aggregating a length below the river bed or ground level of 2,379 ft., of which 1,156 ft. was in sand, gravel, and boulders, and 923 ft. in shale, with occasional small lenticular pieces of limestone. On the east or left bank heavy beds of glacial drifts were encountered and there was some difficulty in putting down stand-pipe and casing. The boulders were broken up with dynamite. In shale, saw tooth bits were used entirely, the hertz bit being used only in the limestone pockets.

The work of setting up the drill was started December 5, 1905, and the first boring started December 8, 1905, with one shift working 10 hours. On January 17, 1906, a second shift working 10 hours was put on.

Shale was found practically level over the entire cross-section at 12 ft. below water. There was apprehension upon encountering an underground flow of water in the upper strata of the shale, but in no case was this more than a few feet below the top of the shale.

Caissons for the permanent piers penetrated the shale from 4 to 6 ft. and the material encountered was accurately described in the record of the borings. The cost of the drilling, including 10 per cent for depreciation of plant and tools, was about \$2,400, or about one dollar per foot.

DRILLING AT CLINTON, IOWA.

In 1908 the Northwestern Railway began tests to locate suitable foundations for a new bridge over the Mississippi River at Clinton, Iowa. The same apparatus, tools, piping, etc., were used as at Pierre, but the manner of working and the materials encountered were essentially different. These borings were started in April, and it became necessary to mount the drill on a scow. Figure 2 on this page shows the drill mounted ready for work. The scow was 15 ft. wide, 32 ft. long on the bottom and 37 ft. long on top, with a draft of 16 ins. when loaded. Experience in rough water showed that a scow 10 ft. longer on top with somewhat more rake to the ends would have been more service-

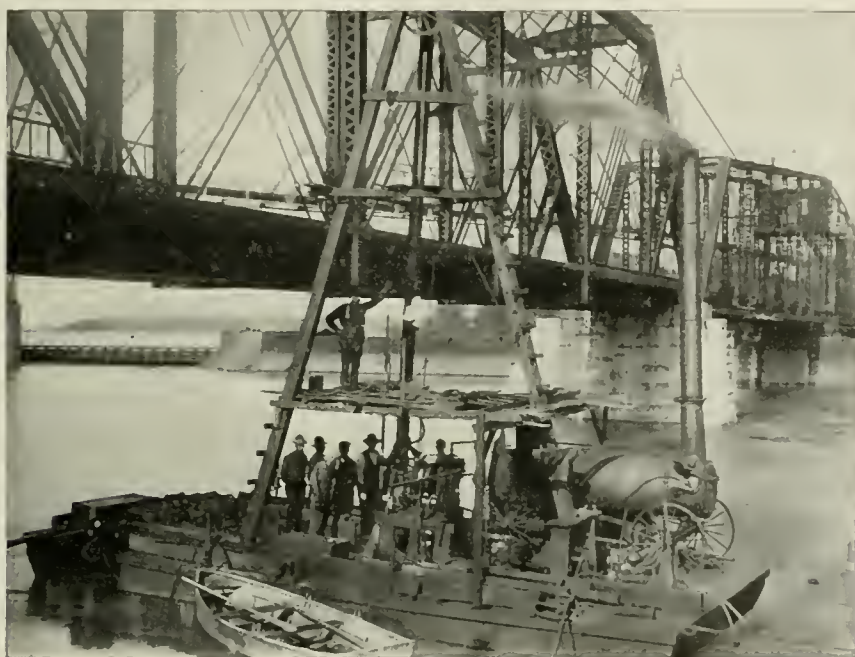


Fig. 2—View Showing Testing Work in Progress at Clinton, Ia.

of a few feet in locating a pier may make a difference in cost of tens of thousands of dollars.

4th. Much can be learned as to the character of the foundation that cannot be learned from the interior of the caisson. In limestone formations subterranean caverns are common, and in both lime and sandstone formations overhanging subterranean cliffs are found. The existence of these can be determined with the drill, but cannot be learned from the interior of the caisson.

INTERPRETING THE BORINGS.

Nearly the whole North American continent north of the Ohio River and east of the Missouri River has at various periods been covered with glacial drift; in fact, the Ohio and Missouri rivers were formed by glacial action. Below the recent alluvial deposits in a riverbed in this district will be found glacial deposits of sand, gravel,

not conclusive evidence that bed rock has not been reached. When such a condition is liable to be found in any locality it will usually be mentioned in the state geological surveys. Boulders of granite and other hard rocks must be removed by placing sticks of dynamite at the bottom of the stand-pipe, withdrawing the pipe, and exploding with an electric battery. Boulders of softer rock can be cut up with the chopping bits and the casing driven through them. As boulders are usually separated by a matrix of sand or clay, the drop of the rods and the wash will show them as boulders and not bedrock in most cases, though this is not always conclusive, as pockets sometimes filled with sand are common in limestone ledges.

No definite rules can be given to cover all cases, and it is best, especially where there is any uncertainty, to put down a hole at each of the four corners of a pier.

able. The tripod consisted of three pieces of Douglas fir, 5x8 ins. and 32 ft. long. An 8-in. wrought iron pipe near the center of the scow, bolted with a pipe flange to the bottom of the scow, made a well for passing the stand pipe, 4½ ins. in diameter, and the casing, 3 ins. in diameter.

The materials encountered were in order as follows: Recent alluvial sands, glacial drift of gravel, sand and boulders, a shale consisting of sand with a clay matrix, and finally limestone bed rock. The upper strata of bed rock was identified by fossils and general appearance as belonging to the Gower stage of the Niagara series of Silurian rocks. This overlaid conformably rock of the Delaware stage of the same series. In the middle of the river the Gower rock and nearly 50 ft. of the Delaware rock had been entirely eroded. Great care was taken to ascertain the possible existence of subterranean pockets or overhanging cliffs in the rock. Only two of these pockets were found, however, both in the same boring, and these were only 1 and 6 ins. in depth. Both were filled with sand, consisting of about equal parts of quartz and dolomite sand. Some of the borings were carried down 30 to 40 ft. into the bed rock to determine the possible existence of these subterranean pockets.

All the boulders encountered were such as could easily be broken with the chopping bit and no dynamite was found necessary. To determine the consistency of the shale, cores were taken out with saw tooth bits working dry, showing perfectly the consistency of the material. The saw tooth bit or the chopping bit working with the pump gave no idea of what this material was, and without the expediency of the dry core an excellent foundation would have been overlooked, and a foundation sought 30 ft. lower. It is intended to use pneumatic caissons in all the piers except the shore piers.

Borings in the limestone were made with a bortz bit when the water was still, and with the chopping bit, taking occasional cores with the saw tooth bits. Fully 95 per cent of the boring in the limestone was made with the bortz bit. The work of mounting the drill was started April 2 and the first hole begun April 7. The work was finished June 6, working one shift of 10 hrs. per day.

The aggregate length of casing put down was 692 ft. The aggregate length of casing driven through hard material was 496.5 ft. The aggregate length of borings in shale was 86 ft., and in limestone 226 ft. The cost was as follows:

Labor	\$ 456.16
Coal	124.41
Depreciation of bortz, estimated..	200.00
Scow	287.24
Depreciation on tools, pipe, etc...	200.00
	\$1,267.81

The scow still has a value which is somewhat uncertain. Omitting this credit, the cost amounted to \$1.83 per foot.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Experience with the Road Drag Under Various Conditions.*

BY S. W. NOTTINGHAM.

The following are some of the principal points that have come up in my experience in the use of a road drag. The road drag has a place to fill. What we want is the best result with the least labor; so the first thing to do is to make a drag, one that will do the best work with the least horse power.

Seven feet is a very nice length for a drag, two planks 2½ in. thick by 10 or 12 in. wide, two cross pieces 3 ft. long (most any width will do from 4 to 12 in.). We will make a left-hand drag (a right hand drag is preferred by many as it is considered more convenient to turn it at the ends of the road) that will run on the right hand side of the road and move the dirt to the left. Set the planks on edge 2 ft. apart, move the back plank 1 ft. to the left, lay your cross pieces on the upper edge of the planks 1 ft. from the end of the boards with the same angle that the boards have (so that when the right end of the drag is pulled ahead the end of the back boards will follow the end of the front one instead of extending out farther as it would do if it were made square). Mark where the cross pieces are and saw in 1 in. on the front side and down to 2 in. on the back side of each plank. This will let the boards lean 5 or 6 in. forward; bore a hole through the cross pieces and down through the plank at all four points and put in ½-in. bolts. Put a block under each of the cross pieces just behind the front board, put a ½-in. bolt up through this. One can take straps of iron and have hooks made, with the hooks up, with two holes in them so as to fit the bolts that are through the front board and those through the blocks. These hooks on top of the drag are to pull by, so they will not be in the way of the dirt. Put a shoe all the way across the front board. Now have your right hand chain about 18 in. long, the left hand 27 to 30 in. long or any length to suit the case. Stand on the back of the drag. This drag is suited for three horses; from 6 to 10 miles is a good half day's work for a team. The conditions of the roads and the kind of weather have much to do with the distance one can go. Three horses can do as much with this leaning drag as four can with one that stands straight up.

*From the annual report of the Illinois Highway Commission.

There are two times to drag roads, wet and dry dragging. Wet is when it is muddy and the muddier the better. Dragging dry is when the road has dried enough so the dirt will not stick. In the summer, there is only about one-half day after each rain when the road is really fit to drag at all. One can use four horses on this drag, but when it is muddy the horses track up more road than the drag takes. When the road is firm it is all right. Have seen the drag weighted and four horses used. When it began to harden, the man used as a weight a box almost as long as the drag and six small rocks. He said they were the handiest things yet. He could move the rocks around and make the drag even, as he wanted it.

Our best roads are where we have good ditches on the sides, some 3 ft. deep or more. The road should be rounding enough to run the water off when the holes are kept filled with the drag. You can not do a road any permanent good with a road that is lower in the middle than it is on the sides. The road must first be put in shape, then you can keep it in shape with a drag. Most of my dragging has been done when the earth was so dry it did not stick. I have had good results on one hill that was worked late in the fall. It was kept dragged in the late winter and early spring, and was a good road when in other years it was bad. That was a year ago. This spring we have had bad roads, and the conditions were such that you could not improve them much with a drag, for there are times when the amount of moisture in the soil is such that it makes dragging practically impossible. Most of our people think that dragging wet does no good and sometimes they say it does harm, but dragging wet is a good thing, for it makes the ground hard when it dries and that is the way we want the roads to be.

I have three kinds of drags, and the best one to use depends on the condition of the roads. In going over four miles of road the other day I found three conditions; first, where it worked nicely, then came mud that was too sticky and was not dry enough to drag dry, then came the black soil with good ditches and tiling. Here the dirt was so soft I had to walk to keep it from rolling up in front of the drag.

Many of the people in this neighborhood think the drag is a great thing, but most of our roads need to be graded up before we can get the best results from dragging.

Macadam Road-Surfacing in the Past and for the Future.*

BY W. W. CROSBY.†

For many years the pavement known under the name of "macadam" has been of great service to the road-using public and has given, under the then existing conditions, varying degrees of satisfaction. This surface is composed of irregularly sized fragments of broken stone varying from 3 in. downward, which, spread evenly over a foundation of the natural earth, prepared and treated with more or less care, are firmly bound together, being interlocked by rolling and then cemented by a mortar of the finer particles. The degrees of usefulness and satisfaction furnished by this "macadam" have so far depended mainly on the following considerations:

1st. The complete and intelligent acceptance by the builders of the theories concerning the necessity for providing proper foundations for the surfacing and the care, in the execution of the work of preparing the foundations, necessary to make the product conform to the theories.

2d. The quality of the macadam material, its sizes and proportions of the different sizes, with the methods of its application.

3rd. The width, thickness and cross-section of the macadam.

4th. The kind and degree of care and maintenance accorded to the pavement after its completion; and

5th. The kind, amount and character of the traffic using it.

To insure all possible brevity, unnecessary argument will be avoided here and complete agreement will be assumed to exist that perfect "macadam" can only be secured under the following conditions:

1st. That the foundation of the natural earth must carry the loads coming on the surface of the macadam; that it must be so drained and compacted as to be able to resist, successfully at all times, displacement under these loads; and that the foundation must be kept separate from the macadam layer and not allowed to churn up into the latter nor the stone allowed to be driven into the foundation, or, in other words, that no mixture of the stone and foundation material can be permitted without detriment to the macadam.

2d. That upon the quality of the macadam material depends the value of the macadam itself; that the stone should be homogeneous, hard, but tough and not brittle, and its fine dust must possess sufficient cementing qualities to "bind" and "re-bind" enough to meet the demands on it. Lack of uniformity in the quality of the material, insufficient hardness and toughness, and lack of cementations will produce only unsatisfactory results.

The methods to be followed in the breaking and applying the stone, must, if economy and the best results are to be secured, provide for the clean separation of the broken stone into preferably three sizes; the application of the different sizes in layers in no case of over 6 in. in thickness measured loose; and for each layer to be thoroughly compacted by rolling sufficient to reduce the voids in it to the utmost possible minimum before the subsequent layer is applied. They must prohibit the use of pieces of stone, in the first course, having a dimension greater than 3 in.; and, in the second course, greater than $1\frac{1}{2}$ in. or with a greatest dimension less than $\frac{3}{4}$ in. No "pockets" of greatly varying sized stone can be permitted in any layer, and the pieces of stone in any layer must be as uniform in every way as it is practicable to have them. No admixture of earth or foreign material can be allowed in any course except at the expense of the results. The top course of the macadam must be of the best possible material, and uniformity of size in the particles, absence of variation from the standard size ($1\frac{1}{2}$ in. maximum dimensions) and the maximum compaction and reduction of voids must be secured in this course especially.

The final filling of the irreducible voids should then be completely and carefully done with an excess of water and sufficient repetition of the watering and rolling to secure success in the result. The filling material must be of varied sizes, from "flour" to the maximum sized particles that will occupy the voids existing in the previous courses, and but little, if at all, exceed in quantity the amount actually needed by the voids themselves.

3rd. The width of the macadam surface must be such as to discourage concentration of traffic in too limited areas and must be sufficient to permit such distribution of traffic as will prevent more coming on the edges of the road than they will bear and as will cause the destruction of the stone surface to begin at the edges of the latter. The thickness of the surfacing must be sufficient to properly protect and distribute the strains to the foundation, and such as will be the most economical in the long run.

The cross-section of the surface should be uniform under similar conditions and only of such slopes as are necessary to properly shed to the gutters the water coming on it.

4th. The maintenance must be constant, careful and complete.

Where these conditions have been fulfilled, macadam surfacing has been found to be competent, economical, and satisfactory under most conditions, short of these of extreme severity of traffic. There have been some objections to it under certain local conditions, such as its dustiness in dry, and the thin, muddy film on it in wet weather, and the impracticability of satis-

factorily cleaning its surface.

Aside from the objections, which are also accentuated by the same causes, any dissatisfaction with macadam has come from the neglect of one or more of the foregoing principles or from extreme traffic conditions.

These extreme traffic conditions are:

Frequency of vehicles, beyond a certain daily number, which number depends on the characteristics of the macadam material used.

Weight of vehicles and loads beyond a maximum, and under the excessive strains of which the larger pieces of stone in the top course of the macadam are separated into two or more smaller pieces; and

Automobile traffic beyond a certain proportion of the whole traffic.

Beyond a certain figure, the number of light vehicles may, by attrition, render the amount of dust from the macadam objectionable to a locality and the laying of this dust may be impracticable or uneconomical.

The crushing strains brought on the pieces of stone in the wearing surface of the macadam by extremely heavy loads may divide these pieces into smaller sizes which then are unequal to the strains of ordinary loads, and the passage, or likelihood of passage, of such an extreme load may render a macadam surface unfitted for a particular locality.

The excess of automobile traffic beyond a fairly small percentage of the whole traffic over a road will, by reason of the effect of the self-propelled, rubber tired, swiftly moving vehicle in disclosing the stone particles, render ordinary macadam unsuited for that road.

The last change in traffic conditions (the advent of the automobile and the growth of its use) has crystallized the opinions of engineers to the need of some change in, or of addition to, the former principles concerning the construction of macadam and there is every probability that when means are agreed on to meet the demands of the automobile traffic it will be found that means have also been found to overcome all of the objections, above mentioned as existing, to macadam except that of the inability of the stone composing the wearing surface to resist the disintegrating effect of more than a certain maximum load. But it is also likely that, even in this, the raising of this maximum may follow by reasons of the better support or protection accorded to the stone particles themselves.

In the effort to meet the new conditions imposed by the increased use of the automobile two distinctly different methods of treating the original macadam surfacing have developed. One is to use the macadam as a foundation for a "carpet" or surface coat of finer material mixed with some form of bituminous cement. The other method is to reinforce the cementing properties of the wearing surface of the

*A paper read before the First International Road Congress at Paris, France.

†Chief Engineer Highway Division, Maryland Geological Survey.

macadam itself, by impregnating it, in the case of already constructed macadam, with a bitumen of sufficient fluidity to insure the proper penetration, or in the case of new construction by the addition of a bituminous cement to the wearing course during the process of construction.

As the methods of "carpeting" the macadam, or surfacing it with a wearing coat of either ordinary asphalt paving mixtures or some substitute for them are not perhaps germane to an argument on "macadam," further discussion of such methods will be omitted here.

The writer believes that if the principles of ordinary macadam, before expressed, are faithfully followed and the otherwise irreducible voids in the broken stone aggregate filled with a long lived elastic cement—such, for instance, as some form of bitumen—instead of as is customary, with a paste of fine stone dust and water—the present problems will be best solved and the resulting macadam give greater satisfaction and have a wider application than ever.

The questions are "What cement or filler should be used?" and "How shall it be put in place?" The highway division of the Maryland Geological and Economic Survey, the Office of Public Roads, U. S. Department of Agriculture, and probably many others, are working on the problem of the material itself, but in view of the complexity of the bituminous compounds, it is not an easy one to solve. It is known that certain qualities are desirable and that certain substances, varying greatly in composition, seem to possess these qualities among others perhaps, in varying degrees. At this writing, however (July, 1908), no definite statement of just what properties or composition a substance should have, to guarantee its success under known conditions, seems to exist. It may, however, safely be expected that this problem will not long remain unsolved.

Having secured a material certain to be satisfactory for this purpose, the problem of getting it into place is faced. Certain principles have been admitted as necessary to theoretical perfection and cannot be sacrificed; neither, of course, can any waste of material be endorsed. Some builders have, in using refined tar, mixed proper proportions of tar, fine stone and coarser stone together, applied the mixture as a top or wearing course, and frequently have secured apparently good results. Others have tried the same process and failed. Success seems to have come mainly from the use of extraordinarily good "tarry" material in the one case and of poor in the others. Good quality of tar may largely offset the loss in the mechanical interlocking of the larger pieces which can but occur from the process of spreading and rolling the pieces of stone with the presence among them of the finer sizes. Undoubtedly, more nearly perfect results would be secured if any sacrifice

of this principle of the mechanical interlocking of the larger pieces were avoided.

Other builders have spread a layer of stone screenings mixed with tar on the first course of the macadam after its compaction by the roller and then spread and rolled the second course into this tarry mixture with varying results. The variety is probably due partly to the differing qualities of the tar and the varying proportions of the tar, screenings and top course stone, and partly to the amount of adherence actually secured to the macadam principles above referred to.

Others have coated the wearing-course stones with the tar; spread and rolled them into place and covered the top with screenings, trusting to their ultimately working down into the voids in the wearing surface. It is doubtful, however, if the voids are ever completely filled by this process and the sacrifice of another underlying principle thus occurs, to say nothing of the waste of tar in this method.

The best method yet devised seems to be that of nearly completing the macadam as if no tar were to be used and then, instead of finally "flushing" (i. e., of filling the smallest voids with the finest sizes of stone by the aid of water) to saturate as nearly as possible the mass with refined tar heated to sufficient fluidity for penetration. Provided the irreducible interstices between the larger stones are filled with the smaller sizes down to the "flour," but the flushing in of the "flour" has not proceeded to that point where the mass would be impervious to penetration by the tar, the results will be practically perfect. Successive applications of tar may be required and some objection may be raised to the time required for this process. It would seem, however, that in view of the at least theoretically better results to be secured in this way and of the fact that no sacrifice in economy of materials nor of any of the principles underlying the construction of macadam is involved, that some extra length of time in the process might be justified. It is entirely possible that, in the investigations regarding the bituminous cement to be used, a vehicle for carrying it swiftly into its place in the stone aggregate may be found so that this objection will be met or, at least, reduced, to the minimum.

The writer believes that the principles of Tresaguet and Macadam before expressed must be followed without deviation if the utmost degree of success is to be secured and that any neglect of them can only result in inferior work. Attempts to provide, on the top of macadam, a carpeting of rock screenings and bitumen, that will relieve the objections of dust or mud and of the dislodging of the wearing surface of ordinary macadam under automobile traffic must be regarded as the abandonment of macadam except for foundation purposes and as efforts toward substitutes for asphaltic surfaces.

It is entirely possible that some such substitutes may be found to be practicable for situations where macadam, previously satisfactory is now becoming unsuitable, but it seems probable that, if the cost and life of such surfaces is considered, it will be agreed that a considerable zone exists between ordinary macadam and "asphalt" that will be most satisfactorily occupied by properly built and pitch-cemented macadam.

Method of Road Maintenance in Cuba.

BY CHAS. MCKERCHER.*

There seems to be a great deal of discussion going the rounds in engineering circles in the United States as to the best method of road maintenance, and it may not be out of place to mention the system of road repairing used by the Department of Public Works in the Island of Cuba, and which has now passed the experimental stage.

While the roads are being constructed, the plans call for a double section house every 6 kilometers, which later on is occupied by the road menders and their families.

The roads of each province are divided up into divisions of from 30 to 40 kilometers and a roadmaster is put in charge of each division.

The road master draws a salary of \$83.33 per month and also is allowed \$1.00 per day for expenses when he is absent from headquarters. He reports to engineer of maintenance or, as in some provinces, to the chief engineer of the province.

The divisions are subdivided into sections of three kilometers and a roadmender is assigned to each section. This man reports to and receives orders from the roadmaster. He is paid \$25 per month and is given the use of a house which is situated at one end of his section. He is responsible for the good conditions of his section.

The work of the roadmender consists in clearing the right of way of the road of weeds, cleaning the ditches and trimming the slopes of the same and repairing any bad spots in the road proper. Also whenever any of the bridges or culverts in the section need repairing this also falls to the roadmender.

On the last day of each month each road mender sends in a report of the work done on his section during the month and also a note of any extensive repairs that should be made. This report is sent to the roadmaster who embodies the reports of his division in one, and forwards it to the chief engineer, who in his turn embodies the reports of all the roadmasters and sends it to the director general of public works.

Whenever any damage is done on any section which the road mender cannot handle alone, a telegram is sent to the

*Civil Engineer, Nuevitos, Cuba.

chief engineer, who sends out the road mending outfit to repair the damage.

Every year, or more often, if necessary, the chief engineer calls for proposals for supplying the department with crushed rock. This rock is distributed along the roads in a greater or less quantity according to the needs of the sections. The rock used in most of the work is a medium hard white limestone with good cementing qualities.

Whenever a portion of the road commences to wear more than the rest the road mender only has to pick it over, take the rock necessary to restore the original cross section of the road, tamp the portion well and put on a good coat of clean sand as a wearing metal.

The chief engineer makes an inspection of all the roads in the province twice every year.

The roadmaster makes a complete inspection of his division once every month and once a year makes a report to the chief engineer on the condition of the road and all bridges, railroad crossings and culverts. This report is made by sections.

The road mender goes over his section once a week to see if there is anything that requires his immediate attention and also inspects his road after each heavy storm.

In his annual report Gen. W. L. Marshall, Chief Corps of Engineers, U. S. Army, recommends that the corps of engineers be increased by the addition of 132 officers, 60 to be employed on military and civil works of construction, 57 to be employed in three additional battalions and 15 for regimental organization. The present authorized engineer corps consists of 189 officers.

Carefully conducted tests at the Sibpur Engineering College, states a recent Consular Report, has demonstrated that tapping the Indian *Pinus Longifolia* does not in any way deteriorate the wood, and does not render the trees more liable to attack from insects. Thirty-eight species were subjected to the tests, with the above results. These tests also demonstrated that the Indian timbers equal the pines of America in bending strength and in rigidity.

According to a Consular Report a successful demonstration of the applicability of gas propulsion to slow-going ships was recently made at Liverpool on the river Mersey. The vessel on which the experiment was carried out is an obsolete British gunboat. This vessel of 700 tons made a trip to the Crosby lighthouse and back, about 14 miles, propelled by gas. The old steam machinery, which was of the usual horizontal triple expansion type, with two navy boilers, was removed and replaced by a single-acting gas-producing plant and five cylinder engines.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Staking Out Curves in Rough Ground.*

BY ROBERT LAIRD,†

An assistant locating in the extreme north, though hard working, honest, ingenious, painstaking and unusually "bush-wise," was surely gaining the reputation of being a slow coach with the head office, because he did not know and did not think out a very simple wrinkle connected with his work.

His ingenuity was sadly misused, and all because he had not conceived the idea that it was and is possible to run in a curve on the ground without establishing a single transit point upon the curve itself; he had a firm conviction that his transitman must of necessity set the transit on the curve—preferably at the P. C., or if not there, then at the P. T.—in the case of a compound curve—he regarded the P. C. C. as a point from which he could no more escape than we all can escape the confidences of our friends.

When his P. C., P. T. or P. C. C. fell within the margins of a lake, in the midst of a stream, or on a nearly vertical rocky wall, as was the case more often than otherwise, he described this as "——— hard luck," and proceeded to bridge the stream with heavy timbers, to drive long plugs for the transit legs in marshes and lake margins, or to erect platforms at rocky faces, establish thereon with care his P. C., set the transit over it, and proceed to another point on the curve—which, being out of sight because of the trees, might or might not prove suitable for a transit point, and this was not disclosed until a line had been cut out thereto and chained. If not suitable, the building operation was repeated or the line abandoned and a second try made for another and more desirable point.

All this is easily avoidable by a much more elastic method than that of laying down a curve by its chords; i. e., by short or semi-tangents to the curve. This method as far as I am aware has not been amplified by any field book writer. Perhaps it has been considered too obvious and simple to merit description, but that case in point—the bridge building person of my experience—seems to warrant a short statement regarding it.

Had he been asked to run in a curve of 10 degrees deflection, he would not have hesitated to disregard the P. C. as a transit point, but would have measured along the tangent, produced the sub-tangential distance corresponding to the degree of curvature desired, there set his transit, turned the 10 degrees, laid down the remaining sub-tangent—which is also the

leaving tangent from the curve—made proper correction for chainage, and gone gaily on; but 50 degrees of curvature was to him quite a different matter.

If the first 10 degrees of a curve can be laid down, so can the following 10, or any other number of degrees.

The leaving tangent of the first part is then the entering tangent of the second part, and for every distance along this tangent there is a corresponding angle of deflection just as truly as there was for any entering subtangential length; and this is true for the third or any following part.

Now to suggest the elasticity of this method. There is no good reason for selecting a certain length of tangent or a certain number of degrees of deflection; the proper considerations which determine these are as follows:

1. Any distance along the tangent to the curve, beyond the P. C., whose abscissa distance from that curve is not too great for the convenient and fairly accurate off setting of stakes, and such that the leveler may easily observe the elevations of the corresponding points on curve, notwithstanding the obstruction to view by trees, vegetation, etc.

2. That the point be so chosen that a good foresight from it may be had.

3. That it be suitable for a transit point.

Suppose, then, we desire to lay out a 3° curve through an angle of 50° to the left of a given tangent, the P. C. of which is L. 320 + 57; this hub is set, if possible, and the tangent is produced to any distance at the discretion of the picketman. This distance for a 3° curve should not exceed 350 ft.

The chainmen are furnished with a table of offsets, at 5 ft. intervals, of tangential length; they offset, if required, to the left L. 321, the offset for 15 ft.; L. 322 that for 145 ft., etc. (Should they mislay this table, they are permitted to use the approximate formula $x = \frac{1}{2} \pi^2 l^2$.)

In the meantime the transit is moved forward and set up at the end of the line. Suppose the chainage of this hub is found to be 323 + 62.1, being a tangential length of 323 + 62.1 — 320 + 57 = 305.1 ft.; the angle corresponding is 18°.69' and length of arc 605 ft.

This angle is turned to the left, and the picketman instructed to cut not less than 350 ft. and not more than 650.

The chainage of the point on curve, ahead of the transit, where this tangent touches is: Chainage of P. C. plus the arc 320 + 57 + 6 + 05 = 326 + 62; the chainage of the transit point back of that curve point, and reckoning from it, is the chainage of that curve point minus the tangential length 326 + 62 — 3 + 05.1 = 323 + 56.9. (The correction for chainage is made at

*A paper read before the Ontario Land Surveyors' Convention.

†Halleyburg, Ont., Can.

the transit point for simplicity.)

With this chainage the men go ahead; offsetting station L. 321, offset for 260 ft.; L. 325, that for 166 ft.; L. 327, that for 40 ft., etc., as before. The chainage at the end of this line is found to be $329 + 72.8$, then tangential length is $329 + 72.8 = 326 + 62 = 310.8$ ft. Corresponding angle is $18^{\circ}.29'$, and arc is 616.1 ft.

This angle is turned and the chainage correction made as before. The new point on curve is $326 + 62 + 6 + 16.1 = 332 + 78.1$. Now, total angle turned is $18^{\circ}.09' + 18^{\circ}.29' = 36^{\circ}.38'$, leaving $50^{\circ} - 36^{\circ}.38' = 13^{\circ}.22'$ still to be run; the corresponding tangential length is 223.8 ft. and arc is 445.6 ft.

The instruction to the picketman, at the second transit point was cut the line 310 ft. to the curve point and 223.8 ft. beyond it or to chainage $332 + 78.1 + 2 + 23.8 = 335 + 01.9$. This hub is then set correctly and the completing angle there turned. It will be noted that this hub must fall on the sub-tangent to the curve or on the tangent passing through the P. C. C. when the curve is compounded.

Chainage is again corrected and the P. T. hub set 223.8 ft. ahead of the transit point, thus completing the curve at station $322 + 78.1 + 4 + 45.6 = 337 + 23.7$.

In the case of a compound curve the process is continued by turning off from this leaving tangent of the first branch the angle corresponding to the distance beyond the P. C. C., proper for the second branch. (If a 1° curve, and tangent 322 ft., then the angle $6^{\circ}.26'$.)

The form of field notes is shown below:

P. T.	L.	3+67
		3
T. P.		1 > 0+45.7 = +45.0
(322.0)		340
		9
		8
P. C. C. L.		7+23.7
		6
T. P.		5+01.9 = +4+99.9
(223.8)		3 > 4
P.	L.	2+78.1
		2
		1
T. P.		330
		9+72.8 = +67.3
(310.8)		9
		8 ()
		7 (0.4)
C. P.	L.	6+62
		6 (0.9)
		5 (offset)
		4 (17.7)
T. P.		3+62.1 = +56.9
		3 (15.2)
(3.03.1)		2 (5.5)
		1 (0.5)
P. C.	L.	320+57

Note.—The sum of the short tangents has no relation to the sum of the sub-tangents to the curve.

You will have noticed that the stakes were offset to the curve, if required; that has not been the custom; on the contrary stakes are set in the lines as cut, but with

the initial letter before the station numbers omitted, and with the words "offset left — ft." written on the back of the stakes, except on those stakes set where the tangents touch; these are fully marked thus, L. 326 + 62.

The reasons for this: Offsets at an exact right angle are often not practicable because of the trees. (For this reason also a close calculation of abscissa is not made, that for the nearest 5 ft. being deemed sufficient.) The rodman and leveler readily find the stakes in this position, and use them—which is, perhaps, doubtful in the case of stakes hidden in underbrush; the topographer also has definite points and elevations to work from. The rear chainman has an undisturbed point at which to hold the chain; these stakes are left standing and are verified by the topographer; the chainmen know that this will be done. Foremen of clearing gangs, when properly instructed, have no difficulty in laying out the right of way correctly.

The chief instrumental advantages of this method, in rough ground covered by trees or broken by water, cliffs, etc., are the avoidability of short sights and the latitude possible in the choice of ground for the transit points. Curvature being introduced, largely to avoid obstructions, and the curve running around the hills, the tangents are often in better ground, being outside the curve, whereas the long chords being inside often cut across very bad ground.

It might be noted, too, that for equal lengths of abscissa to a curve there is always one less transit point by this method than by that of a chord method.

	6° 26'	643.3
1 Curve Left 6° 26' L. C = 643.3'		
	13° 22'	445.6'
	18° 29'	616.1'
	18° 09'	605.0'
	50° 00'	1666.7
3 Curve Left 50° L.C. = 1666.7		

Other advantages are: The picketman and axmen do not wait for the chainage, but cut ahead to any point at the discretion of the picketman. The chainmen have plenty of time to properly do their work, and do not delay others, as the chainage of the hub at the end of the line is not required until

the transit is brought forward and set up, except in one case; i. e., the final hub.

One transit point alone, no matter how long the curve (except it be compounded, when two are set) demands exact placing, and, that being an unusual operation, is more likely to be properly performed. A chainman who will insist on and will secure the exact setting of a point when it is a duty repeatedly performed is a jewel rare. Errors of considerable magnitude are liable to occur, especially when one of the party is an habitual talker; the fascination of a joke completely dulls the fine edge of observation. A hub may be driven plumb or when driven be several inches out of place, and the point taken on it anyhow, so that the point of the joke may not be missed.

The procedure, to emphasize the idea in all minds that this is an important duty and one that must be done properly has been as follows: When a hub is to be set to chainage, the chainmen first lay off the correct plus, the picketman drives the hub; the chainmen lay off the plus again, marking a line at right angles to the transit line across the hub; the picketman takes point therein. If for any reason the hub does not contain both, the operation is repeated until it does. The essential feature of this is that the chainmen, who are held responsible, shall repeat the measurement as often as necessary, and shall remain in position to repeat it until after the signal has been given for the transit to come ahead.

The transit man, when in position to look back along the line, sets his vernier at 180° , sights back, and revolves the upper limb, but does not plunge the telescope. His vernier is now at 0° , and the angle is set off by direct reading. This was found necessary, as the cross-hair diaphragms of the instruments supplied were much too thin, and in the extreme changes of temperature (often 40° in a morning and as much in the afternoon) considerable hourly variations in the line of collimation were found.

The chainmen have been required to blaze a large tree on that side facing the hub, and to mark thereon all information, as at P. C.: "P. C. 3° C. Left 50° ," or as at transit point: "T. P. A. Left $18^{\circ}.09'$. $323 + 61.1 = 323 + 56.9$."

The picketman's instructions included the following:

Hubs shall not be set, where avoidable, in soft ground or in ground that is worked by the roots of a wind swayed tree, nor point taken on a stone nor on bare rock. (It is possible that tangential transit points, being as they are distant from center line, may remain through construction days and furnish permanent reference marks.)

Hubs shall not be set, when approaching a steep rise, close up to the foot of it, but far enough back therefrom so that the transit may be able to see to the top of it, nor so far beyond the crown of the rise that more than 2 ft., at the foot of the picket, is hidden from the transit thereby.

A general order to all: No one shall stand in the line, neither between the picket

and the transit, nor behind either, that their signals may not be obscured.

This method may be combined with the chord method by setting a hub at any C. P. and then proceeding in the usual way, and may be used at any time in avoiding obstructions, etc.

In the event of an inaccessible P. C., the tangent is produced to a convenient point, the proper angle turned there and a point on curve set; thence the remainder of the curve is run in.

Should an obstacle cover the P. C. and prevent the production of the tangent, a hub is set in the tangent, an angle turned, and the proper tangential distance set out therefrom; through the latter point a line is run parallel to the tangent, whose length is equal to that tangential length already laid out, plus the distance from hub on tangent to P. C. This is now a point on curve, and a line through it parallel to the sight line off the tangent is also tangent to the curve,

A Successful Investment in an Industrial Railway.

BY JOHN M. BRUCE, ASSOC. AM. SOC., C. E.*

It would be hard indeed to frame a more difficult set of conditions and limitations under which to handle material than those confronting the Newark Lime & Cement Co. in its old plant at the foot of Bridge street, Newark, N. J.

The plant itself represents the growth of the company during its ninety years of prosperous development, and, like all old plants, it has been added to here and there as the business grew and the necessities arose, so that any intelligent general plan for utilizing the space at hand has been out of the question.

The company's gypsum storage yard and shed are located in the heart of Newark, where it is impossible for them to secure additional space. The plot itself is an irregular kite shaped plot and varies in con-

were unloaded by the use of derricks on the bulkhead, operating 500 lb. buckets. These buckets unloaded into the old fashioned wooden dump cars.

These dump cars were hoisted to the top of the storage shed, up an inclined railway, and were from there shoved by hand along the tracks to the different parts of the shed.

The cost of handling with this equipment averaged 21 cts. per ton and the unloading of a 1,600 ton vessel consumed an average of six days.

As the charter price of these vessels is approximately \$150 a day, it can be readily appreciated that a large incentive was offered to the company to devise a more expeditious and economical method for unloading.

The gypsum comes from the quarry in very uneven sizes, running from two man stone down to dust, and, although many experiments have been made, it has been



Fig. 1—General View of Plant and Towers.

so that the remainder of the curve may be laid out therefrom as desired. An obstacle within the curve may be avoided by following a tangent from any suitable point on the curve until that obstacle is passed, thence setting a point on the curve and continuing as usual.

The field book published by Edward Butts contains a table of tangents and arcs for each minute of deflection for curves of whole degrees from this by inspection or by simple multiplication one obtains the angle and arc corresponding to the stated tangent.

The value of natural gas produced in the United States in 1907 was \$52,866,835, as compared with \$46,873,932 in 1906.

The total production of the various kinds of hydraulic cement in the United States in 1907 was as follows: Portland cement, 48,785,390 bbls., valued at \$53,992,551; natural cement, 2,887,700 bbls., valued at \$1,467,302; puzzolan cement, 557,252 bbls., valued at \$1,443,998.

tour from about 2 ft. above high water to 25 ft. at the rear of the shed, about 250 ft. from the bulk head.

The river at this point is narrow and winding and has only a depth of 16 ft. at high water.

The steamers used by the company for bringing the gypsum from their New Brunswick quarries on the bay of Fundy draw about 16 ft. loaded. It is impossible for these steamers to go up or down the river except against a strong tide, as they cannot negotiate the curves and bridges unless they have this tide to help them steer with. It is, therefore, necessary to unload part of the cargo on to barges down the river and some 500 tons of each 1,600 tons are thus transferred and brought up after the steamer.

The problem to be discussed in this article, however, is not that of the water transportation, but of the handling of the gypsum from the steamer into the storage shed. Up to three years ago the steamers

found impossible to devise any means for removing the material from the ship's hold except with buckets and stevedores.

After a very careful study of the situation, Mr. Wm. A. Bishop, the general superintendent of the plant, decided to install an overhead industrial railway fed by three hoisting towers. He intrusted to the Wonham & Magor Engineering Works, 129 Broadway, New York, the design and execution of the railway. The towers themselves, Fig. 1, are of his own design. They are exceedingly efficient and economical in first cost, as they contain several thousand feet less of lumber than any tower of similar capacity heretofore built.

The towers are mounted on two rails, one on either side of the deck, and take the power to run the electric hoists from the overhead T rail, used to supply the industrial trolley.

These towers each have a capacity of 60 tons per hour, but in practice they actually handle from 25 to 40 tons per hour, being limited by the ability of the stevedores to load the buckets in the holds.

*47 West 34th St., New York City.

A hoist direct connected to 25 H. P. motor operates each tower.

A thoroughly ingenious safety device to prevent any possibility of the towers overturning is effected by the bolting of the inner rail for the ground current, leaving the outer rail with no bond, thus if the

and the underwriters would not allow a grounded current to be used in lighting.

The switch-board is so arranged that the load of one dynamo can be shifted to the other in the event of a breakdown, so that the most necessary operation at the time can be maintained.



Fig. 2—View Showing Cars Hauling Tower.

tower starts from its base, the current, of course, is cut off, and being relieved of its load it will naturally fall back into position. This is in the nature of an extra precaution, as the towers are so balanced as to make the possibility of such an accident most remote. The towers are readily moved from one hold to another of the vessels by hitching on two of the cars, Fig. 2.

The car equipment consists of three electric gable dump cars of about three tons capacity, operated with an 8 H. P. General Electric motor.

The cars, Fig. 3, were designed to meet Mr. Bishop's ideas and great attention was paid to all the details of their design and manufacture, contributing toward rapidity and ease of operation, simplicity, durability and low cost of upkeep.

With this equipment the time of unloading the vessel has been reduced from the average of six days to 48 hours, the actual working time used being from 17 to 22 hours, no night or overtime work being required, and no vessels have so far failed to get out on the second day's tide in exactly 48 hours after it was docked.

This one feature of the equipment saves \$600 per trip, or, with an average load of 1,600 tons, the average saving in this one point alone is 37½ cts. per ton.

The power for running the plant is generated from a 75 K. W. dynamo and a direct current of 250 volts is used.

A twin dynamo is used by the company for lighting the plant because the current used in the railway and hoists is grounded

As this is a small factor in the power consumed in the plant compared to that required for the crushing mills, the cost of power is exceedingly low, being only 1¼ cts. per K. W. hour.

In actual practice, the hoisting engines

The labor employed is as follows:

Three motormen at \$1.50 per day....	\$ 4.50
Three towermen at \$2 per day.....	6.00
Two helpers at \$2 per day.....	4.00
One weigher.....	3.00
One foreman.....	3.00

Total\$20.50

This makes a total cost of \$2.05 per hour for labor, or a labor charge of 23 cts. per ton.

While the foreman's wages are charged entirely to the work, he spends less than half of his time in directing it.

The cost of upkeep of the cars during the past three years has been as follows:

A little less than \$50 has been spent for repairs, and the plant mechanic, at \$3 per day, has averaged three days per month on repairs and maintenance, making a total charge for maintenance of \$125 per year.

In considering the time of the mechanic who maintains the cars, it should be understood that he makes every adjustment necessary, even to the lubrication, nothing of this kind being attempted by the motorman.

As the cars handle approximately 50,000 tons of gypsum and 8,000 tons of coal for the plant per year, the cost of upkeep has been 0.2 ct. per ton. The average round trip of the cars is about 750 ft., or, approximately, seven trips to the mile.

The cost of maintenance and wear and tear on the towers has been approximately \$300 per year, or 0.5 ct. per ton.

From these figures it will be seen that the total cost of hoisting, conveying and dumping the gypsum under the new condi-

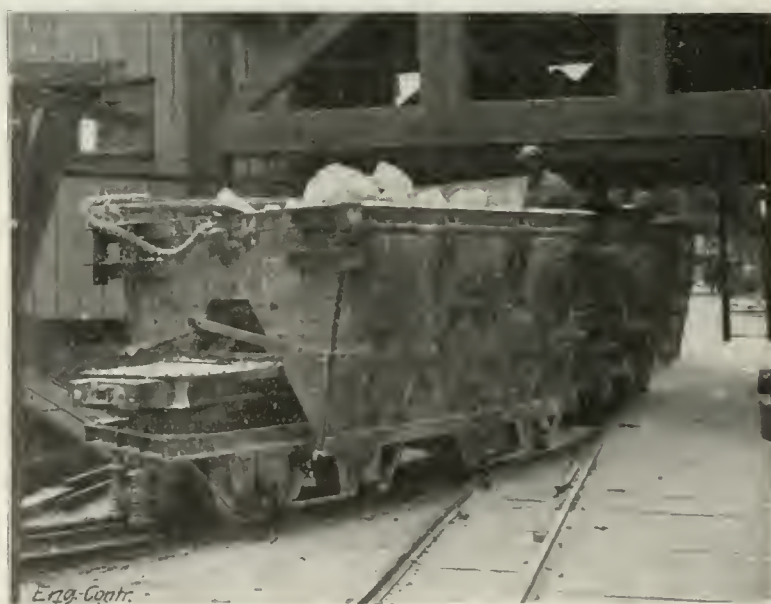


Fig. 3—View Showing Dump Levers and Angle Lip at Bottom of Sides of Cars.

and cars require an average of 60 H. P. In other words, the cost of power is almost exactly 60 cts. per hour. As the unloading and stacking is done at the rate of 90 tons per hour, the total cost of power is ⅔ ct. per ton.

tions is 23 ct. for labor, 0.7 ct. for power, 0.2 ct. for wear and tear on the cars, and 0.5 ct. for wear and tear on towers, or a total cost of 3.7 ct. per ton.

The cost of loading the buckets by stevedores has remained unchanged at an

average of $8\frac{1}{4}$ ct. per ton, bringing the present cost of handling to 12 cts. a ton, as against 24 cts. under old conditions.

As above stated, the plant handles an average of 50,000 tons per year of gypsum, which makes the saving on the steamer charge at $37\frac{1}{2}$ cts. per ton \$18,600. On the handling of the 50,000 tons of gypsum and the 8,000 tons of coal at 12 cts. a ton, \$6,960, making a very handsome total of \$24,560 saving per year.

The cost of the three cars complete was approximately \$5,400, or \$1,800 apiece. The track, which was also supplied by the Wenham & Magor Engineering Company, cost \$3,000.

The T rail installation used as a trolley wire and the other electric connections cost approximately \$1,000; the towers cost \$5,000 each and the frame work and deck cost \$4,000. With a total cost of \$10,200, the saving of \$24,600 represents an annual dividend to the company of over 60 per cent.

It is unfortunate for the sake of an analysis that it has been impossible to divide the cost of power between the cars and the towers, but Mr. Bishop states that the cars have used about 25 per cent of the power, so that any one desiring to make a further analysis of these figures can separate them with approximate exactness.

Methods of Cofferdam Construction*

The proper meaning of a cofferdam is a water-tight enclosure. Its construction depends on the depth it is to be carried, the depth of the water and soil, and character of the soil. The depth that a cofferdam is to be carried down is, in most cases, a fore-cited conclusion. This at times fails, where it is necessary to put in artificial foundation, especially so where you have 10 or 12 ft. of water. Unless you drive the staves far in advance of the excavation, the water is very apt to break under them during the process of driving the piling. If the soil is clay, you will experience very little trouble; if sand and gravel, the water is very apt to force its way under the staves.

The size of the cofferdam clearance around the pier or abutment seems to vary considerably. It should be made as small as possible—the smaller the dam the less water it will hold, and that means less tax on your pumps; 6 ft. is needed in one end for a centrifugal pump. Beyond this a 2-ft. clearance on the inside of the wale timbers is plenty.

This dimension and the depth determined—if to be constructed in water—next in order is to drive four piling, if nothing else to anchor to, just inside of the frame at each corner. Next in order is to put in the wale timber frames. If staves are of the Wakefield pattern, 3 ply 3x12, frames from 4 to 5 ft. apart made of 12x12 are necessary. The struts should be of the

same, and not to exceed 6 ft. apart. It is very necessary to have three of the frames set up; if in water, the frames should be settled so the lower one rests on the river bottom. Care must be taken to keep the frame level.

The driving of the staves is the next thing in order. As they are set up they should all be driven some 2 or 3 ft., just enough to hold them until all of them are set. This done, follow around and drive them down 2 or 3 ft. farther. The advantage gained by setting up all of the staves as indicated is to keep them from spreading. If staves are very long, it may be necessary to bolt one to the upper frame occasionally when they are set up and driven the first time; at the second driving bolts can be removed. It is absolutely necessary to keep the staves driven as far ahead of the excavation as possible, in order to keep the pressure from crowding the staves in at the bottom. In this connection, too, it must be understood that when the excavation has proceeded far enough below the lower wale timber frames, another frame must be put in. It may be found necessary, on account of very hard driving, to put this frame in before the regulation distance has been reached, in order to safely stay the staves from crowding in. In such cases jacks can be set between the frame just put in and the one above it, and crowd the lower one down, as fast as the excavation permits, until the regulation distance has been reached. If these precautions are not taken, the staves are sure to crowd in, thereby reducing the free space that has been allowed between the curb and the masonry.

The method of driving the staves has not been touched upon as yet. For such staves as have been referred to in this subject—3 ply 3x12—either a steam hammer or a common one such as is mostly used, weighing 2,500 to 2,800 lbs. on a 5 to 8 ft. stroke—either one of these hammers used in a common land or unmounted driver can be made to serve the purpose. The one found most practical is a short set of leads, say not over 16 to 20 ft. long, swung on the end of the derrick boom with a hammer weighing not to exceed 1,400 lbs. The advantage of a driver of this kind over the other two is, it is more simple and is easier to handle, when driving, hammer can be kept directly over the head of the stave that is being driven, and when through driving is laid down out of the way and when needed is very quickly picked up and put in operation. One man is all that is needed to hold the lower end of the leads in place.

Thus far this report refers to cofferdams of rather heavy construction. When knowledge is at hand of this class, it is a very easy matter to master the smaller ones.

Mr. F. E. King, Asst. Eng., Chicago, Milwaukee & St. Paul Ry., gives the following method of building cofferdams:

My experience has been entirely with

wooden sheeting. The methods employed varied more or less with each particular job. What might be best at one particular point might not be best in another. Ordinarily, however, we construct one or more frames to define the size and shape of the cofferdam. With the frame in position, the driving is usually started at one corner and continued in one or both directions around the frame. If the cofferdam is to be of considerable depth, the driving is usually done with steam power. Otherwise the sheeting is driven by hand by means of iron rams. These rams have a bell-shaped head with a handle about $1\frac{1}{2}$ ft. long, striking face about 6 ins. in diameter and weighing 50 to 85 lbs. These rams are operated with two to four men. The driving is continued around the dam until the sheeting have all been driven as far as conditions will permit. If only one frame has been used to start with, other frames are added as the excavation proceeds.

Where the cofferdam is only four or five feet deep, I have used wale timbers as light as 3x6 ins. turned flatwise against the sheeting. Where the cofferdam has been 6 to 10 or 12 ft. deep, the most satisfactory timbers I have ever used is second-hand car sills or timbers of equal dimensions. These are usually $4\frac{1}{2}$ ins. to 5 ins. thick by 9 ins. to 10 ins. wide. These timbers were turned flatwise against the sheeting. For depths of greater than 10 to 12 ft., 12 in. by 12 in. timbers have proven most satisfactory. The spacing of the wales varies considerably with conditions. If a single thickness of 2-in. sheeting is being used, the distance ought not to be more than 3 to $3\frac{1}{2}$ ft. If Wakefield sheet piling composed of 3-in. plank are being used, however, I have found the distance of 6 ft. to be quite satisfactory. If the Wakefield sheet piling are constructed of 2-in. plank, I have spaced my frames about 4 to 5 ft. apart.

If the cofferdam is of sufficient depth to warrant driving round piles for guides I have usually held the wales in position by means of a few spikes through them into the piles. If round piles are not used I have sometimes held the frames in position by means of guy lines or braces to some available structure.

The framing of the wale timbers has usually been done by halving them at the corners and then bolting them or spiking them through each piece. Where several of these frames are used one above the other I have separated them by means of struts of the required length and tied the various frames to each other by means of vertical rods through two successive frames.

Where the cofferdams do not exceed 10 or 12 ft. in depth I have found second-hand 6x8 in. bridge ties or second-hand car sills make very satisfactory struts. In some cases I have used pile heads flattened on two sides. For depths exceeding 10 or 12 ft. I have generally used 10x10 in. or 12x12 in. timbers. The framing of these

*Abstracted from the report made by the committee on cofferdams at the October meeting of the Association of Railway Superintendents of Bridges and Buildings.

struts usually consists of square butt joints with the wale timbers. If struts are also used at right angles to these they are usually cut and fitted between so as to occupy as little room as possible and also prevent the first mentioned struts from buckling.

I prefer to use single sheet piling for shallow pits and Wakefield for deep pits. The single sheet piling used consists of 2x8 in. lumber dressed and matched. This gives a thickness after dressing of about 1½ in. I have used this sheet piling successfully for cofferdams of 10 to 12 ft. deep. Where depth like that was encountered and sometimes for very much less depths it has been necessary to place an embankment of earth around the outside. For Wakefield sheet piling 2x10 in. lumber and 3x10 in. were used. My experience with the 2x10 in. lumber has not been satisfactory and I do not recommend its use in any case. The Wakefield sheet piling composed of 3x10 in. lumber in single pieces or in spliced lengths have proven very successful. In splicing this material I have always figured on a lap of 6 or 8 ft. For lumber 10 ins. wide I make the tongue 3½ ins. For holding the combined pieces of the sheet piling together I generally use ¾-in. bolts at the top and bottom and at the splice, the balance of the length being held together by ¾-in. boat spikes of the required length. As to the points used on the sheeting, ordinarily it was sharpened with a chisel point, equal amounts being cut away on either side. It is necessary, however, to increase or decrease the amount of sharpening done on each side of the sheet piling in order to draw it in the desired direction while driving. The lower forward corner of the sheet piling is usually cut away somewhat in order to draw the sheeting up to those already driven.

I have had very little experience with double lines of sheet piling. Where used, however, I find that puddle clay or black loam was quite satisfactory filling. In some cases where nothing better was available I have used fine sand with fairly good results.

In most cases I have used 3x10 in. pine for Wakefield sheeting, the tongue piece being dressed on four sides and the two outside pieces being dressed on one side and two edges.

I have used the ordinary track driver with drop hammer, roller driver with drop hammer, and scow driver with steam hammer. I have also used 8x16 in. timbers in the leaders of a track driven for the hammer, these timbers being as long as could be worked in the leaders. Ordinarily, however, the drop hammer used has been the usual iron hammer of 2,200 to 2,800 lbs. weight. Usually a stroke of 6 to 15 ft. is all that conditions require and the strength of the plank would permit.

Last year I put in a cofferdam in water varying from 6 to 12 ft. deep. The bottom of the river was composed of sand covered with riprap and boulders. I found

it impossible to rake this rock out of the way of the cofferdam. In order to get Wakefield sheet piling driven I used a steel track rail in the leaders of the track driver and drilled a channel through this rock for two or three feet in advance of where I was driving; then I would drive sheet piling in the channel, after which I would resume drilling for additional ones.

Where trees and rocks have been encountered in constructing a cofferdam, I have usually driven the sheet piling down onto the log and close up on both sides. If I was then able to pump the water out, I dug down and cut off the tree so as to drive a sheet piling past it. If that cannot be done I usually use a large chisel operated by block and fall for chopping the log in two. In some cases, however, where the trees or logs were simply on the bottom of the stream I have been able to get a hook or chain onto them and drag them out of the way. In such cases it was frequently necessary to use a hoisting engine pile driver or locomotive to do the pulling.

Mr. A. S. Markley, Supervisor B. and O. Chicago & Eastern Illinois Railroad, wrote as follows:

In 1892 we had occasion to extend piers in Kankakee River bridge for building double track across that stream. Water at that time was three to five feet deep, current running three miles per hour; bottom of stream solid rock in courses of from 4 to 10 ins. thick. After several attempts to maintain a dam with 2-in. plank, double thickness, with broken joints and clay outer wall, we were obliged to (on account of failure to keep water out) substitute Wakefield triple lap sheet piling, using gravel for outer wall, 6 ins. deep around bottom end of piling. In preparing the Wakefield triple lap sheet piling for service we sharpened them the wide way, or parallel with the width of the plank on both inside and outside, leaving the sharp point in center of center stave. By doing so and driving them firmly onto the stone, the point adjusted itself to any uneven surface that might occur on the surface of the stone and prevented water from entering into the dam between the sheet piling and stone. Care was taken to prevent bruising the point or brooming it, and to hold piling up close to each other edgewise when setting it as well as driving, which was done with 20-lb. hammer. This method overcame all of our former difficulties. When leaks occurred in joints of staves, a little coarse sand run down on outside over joint of stave soon closed and calked up the leak in the joint. Only one course of ship lap was used, made of 2x8 in. pine with 2-in. tongue and groove, which the center piece formed, nailed together with 30 d nails. Two waling pieces were used, 6x8 ins., flatwise, 6 ins. from bottom of dam and 4 ft. between them, halved together at corners and intermediate joints. Struts 8 ft. apart, 6x8 ins., were used to hold waling pieces or sides apart. Vertical

braces were used to hold dam waling pieces in position vertically until relieved by masonry. Piers being only 7 ft. thick, no struts were required long way of dam; staves were used some eight or ten times. Occasionally one would break or get damaged by excessive use. Braces were nailed across all corners of waling pieces to further stiffen the dam laterally.

In clay or soil in shallow work, double thickness 2x8 ins., or 2x10 ins., driven with broken joints, is preferable for both easy placing and economy. When quicksand or similar material is found, Wakefield's is preferable and most practicable and economical. The former applies to 16 ft. or less. Waling pieces should not exceed 4½ ft. apart, 8x10 ins., halved together at corners and intermediate joints; joints scabbled on each side to insure stiffness, with 3-in. plank full width of timber, 3 ft. long, corners thoroughly braced at 45° angle; girts 8x10 ins. for 12 to 14 ft. wide dam, 8 ft. apart; first waling piece not to exceed 12 to 18 ins. from bottom; shores of 4x4 ins. between waling pieces set under each strut properly braced sidewise to maintain the distance. It is on rare occasions and under the most favorable conditions that wood staves can be driven to exceed 16 ft. in depth.

In inserted dam sheeting should in all cases be Wakefield triple lap sheet piling in any class of material thoroughly braced same as upper section with 10x12 in. girts 8 ft. apart, or at such distance as will prevent holding waling pieces in line. Character of material that surrounds the cofferdam must determine the size and number of pieces and the intervals to be placed apart.

Various methods are resorted to in driving sheet piling, depending on firmness and character of material. Usually an 8x10 in. piece, 5 or 6 ft. long, 2-in. gas pipe, 3 ft. long, passing through the ram to hold to, and top pointed for hand to grab to hold ram in line while driving, is used. Where this method fails pile driven with steam hammer and follower is applied; usually the weight of hammer alone serves the purpose.

The total production of hydraulic cement in the United States in 1907, according to a report of the U. S. Geological Survey, was 52,230,342 bbls., valued at \$55,903,815. In 1906 the production was 51,000,445 bbls., valued at \$55,302,277.

Women are largely employed in Prague and elsewhere in Bohemia as ordinary day laborers in the construction of buildings. They mix mortar, sift sand, and carry bricks and mortar to various parts of the buildings being constructed. For such service they are paid from 32 to 37 cts. per day. Women also unload coal, carrying it from the wagon on the street to the cellar of the building. For this they are paid 40 cts. per day, and work from 6 a. m. to 6 p. m., with an hour for dinner.

Methods and Costs; Some Old, Some New.

Cost of Subgrading for Roads.—The following data relate to moving 1,860 cu. yds. of earth on a public road. The work was in the nature of subgrading, the cutting running from 3.6 to 0.5 ft. and the fill from 1.5 to 0.0. The contractor was helped out by a culvert that took 300 cu. yds. at the toe of his cut. The average haul was 460 ft., as platted up from the engineer's profile of quantities. The contractor used four big mules to do the plowing, one team for snap, two wheeler loaders and one dumpman and wheeler. No. 2½ wheelers were used. Wages were:

Men, per hour.....	\$0.20
Teams	.40
Foreman (allowed).....	.40

The cost per cubic yard was:

Foreman	\$0.0204
Wheeler loaders	.0139
Plowing	.0268
Snap	.0193
Hauling	.0666
Dumper	.0096
Total	\$0.1566

Life of Timber in Trestle Bridges.

A committee report of the Association of Railway Superintendents of Bridges and Buildings gives the following data, obtained in response to a circular letter to members of the Association, on the life of timber in pile and frame trestle bridges. For caps for the structures, 3 railroads used long leaf pine, nine roads used douglas fir, two used oak and one used white pine. The average life is as follows:

Long leaf pine, average from 12 roads, 10 years.

Douglas fir, average from 8 roads, 10 years.

White or burr oak, average from 2 roads, 11 years.

One road used galvanized iron covers over a long leaf pine cap, and reported a life of 8 to 10 years.

For stringers, 13 roads used long leaf pine; douglas fir is used on 10 roads; white oak on one road and white pine on one road. The average life is as follows:

Long leaf pine, average from 13 roads, 10 years.

Douglas fir, average from 10 roads, 11 years.

White oak, average from 1 road, 10 years.

White pine with iron cover, average from 1 road, 14 years.

For ties, 10 roads used long leaf pine; 5 roads used douglas fir, and 4 roads used white oak. The average life is as follows:

Long leaf pine, average from 10 roads, 9 years.

Douglas fir, average from 4 roads, 12 years.

White oak, average from 4 roads, 10 years.

For piles, 12 roads used white or burr

oak, 7 roads used white cedar; 3 roads used creosoted pine, and 2 roads used red cedar. The average life is as follows:

White or burr oak, average of 10 roads, 10 years.

White cedar, average of 6 roads, 17 years.

Red cedar, average of 2 roads, 12 years.

Treated pine, average of 2 roads, 14 years.

Moving a Tank by Floating in Temporary Pond.

Two steel tanks, 40 ft. in diameter, 25 ft. high, each of 235,000 gallons capacity, furnished water to a certain section of Pittsburg, Pa. One tank rested on a concrete foundation, the other on layers of 4-in. pine plank, laid transversely. This timber foundation, after about 10 years' use, became decayed, and it was decided to substitute a concrete foundation. To allow of this the tank was moved horizontally to a temporary side by the following method. Calculations were made and it was determined that 11 ins. of water would be required to float the tank, and marks were made on the tank to indicate the draft. An embankment was built accordingly, enclosing the existing and the temporary site of the tank, forming a pond. Posts were placed in the ground corresponding to the periphery of the tank and were uniformly distributed to support the bottom. They were all set at a given level and high enough to give access to bottom of tank for painting. In the meanwhile the decayed timber foundation was pinned down with long drift bolts driven through it into the earth. Water was then let into the pond from the other tank which was near-by, and the second tank floated. Some trouble was caused by the decayed timber adhering to the tank, necessitating suspending operations until the timber was removed. The pond was again filled, the first water having escaped by seepage, and the tank floated to its temporary site and settled on the posts. The concrete foundation was then built, the pond again filled, and the tank floated back to its original position. Before moving the tank bench marks had been made so in resetting the tank it could be placed practically in its original location. Previous to floating the bottom of the tank was well braced on the inside to prevent upward deflection; however, some arching of the bottom occurred. The necessary guylines and tackle for moving were gotten ready, and as soon as flotation occurred, it was moved from one site to the other, requiring about ten minutes in transit. As a final operation to complete the work, the space between the bottom of the tank and the foundation was grouted in. Neat cement was used, as a grout with a mixture of sand would precipitate and not flow the distance from the center of the tank to the circumference. In pouring the grout, an indication of the complete filling of the space was a frothing all around the circumference of the tank, indicating that the void had been filled.

The work was described by Mr. William Martin in a paper read before the Western Society of Engineers.

Cost of Building a Wire Fence.—Following are costs of building 6,650 ft. of 4-wire fence, posts spaced 16 ft, as built recently about the top works of a coal mine near Denver, Colo. The work was done by regular employes on idle days during the summer, which accounts for lack of uniformity in day wages, and also for a comparatively high labor cost. No special item of superintendence is charged as the force was so small that the overseer also made a hand.

Labor:

Surveying line, 3 days at \$2.50.....	\$ 7.50
Digging holes, 14 days at various....	36.00
Setting posts, 7½ days at \$2.50.....	18.75
Stretching wire, 8½ days at various..	23.50

Materials:

	Cost.	Freight.	Hauling.	Total.
Posts	\$75.00	\$25.00	\$6.50	\$106.50
Wire	56.42	2.59	1.25	60.26
Staples ...	3.52	(Included in wire)		3.25
				\$170.01

An 8-hour day was worked. The item digging holes includes 1 day, man and team, at \$3.50, and the item setting posts includes 1½ day at \$2.50, setting braces. The holes were dug with post augur to a depth of about 12 in. where the ground was too hard for further progress. The holes were then filled with water after which they could be deepened to from 20 in. to 24 in., or as far as the earth had been dampened. Wires were stretched as follows: The reel was mounted on back of wagon box and several hundred feet of wire reeled off. The back end of wagon was then raised off the ground and a post placed between the rear axle and the ground to prevent the wagon running back. The rear wheel was used as a tightener by taking a couple of turns of wire about hub and turning wheel around by hand, or by a bar through spokes against wagon bed. A comparative cost per mile of the above fence and the fence at San Antonio, Tex., mentioned on this page in our Nov. 11 issue is as follows:

	San Antonio Per Mile.	Denver Per Mile.
Posts	\$56.30	\$85.20
Wire and staples.....	48.20	50.80
	\$104.50	\$136.00
Digging holes	40.40	28.80
Setting posts, tamping posts, stringing wire..	35.50	33.80
Running line		6.00
	\$75.90	\$68.60
Total	\$180.40	\$204.60

The chief difference lies in cost of posts, those used near Denver costing 50 per cent more than those used at San Antonio. We are indebted to Mr. F. W. Doolittle, Urbana, Ill., for the above information.

A New Design of Ratchet Jack.

The accompanying illustration shows a ratchet jack of novel design and particularly high efficiency. Aside from the use of better materials and heavier general construction and more accurate workmanship, little progress has been made in the design of ratchet jacks for some years. In the jack shown, however, a number of improvements have been made which the manufacturers claim place it in a class by itself.

The rapidity of operation makes ratchet jacks popular with users. Prior to the introduction of the jack illustrated, however, it has been deemed inadvisable to use ratchet jacks beyond a capacity of 15 tons. In fact manufacturers have not encouraged the use of ratchet jacks beyond this point. It has been shown that even a 15-ton jack, though well made in every particular, reaches its limit at that mark and there is a tendency of the teeth to upset when un-

successfully arranged and works perfectly. An unusual but improved arrangement for changing the direction of the lifting bar or rack has also been adopted. It is simple and very handy for the user, as may be seen from the illustration. In operation the jack is single acting, the load being raised on the downward stroke of the lever.

The illustration shows the new jack to be particularly strong in design. The frame and small working parts are malleable iron, the socket lever of open hearth steel, the rack of high carbon open hearth steel, the pawls are drop forged and case hardened and the fulcrum pin is high carbon steel, tempered and ground.

A test to discover the mechanical efficiency of the new jack showed the astonishing record of 77 per cent. When it is considered that ratchet jacks generally show a mechanical efficiency of about 40 per cent, the unusual qualities of this new design are apparent. This jack is made by the Buda Foundry & Manufacturing Co., of Chicago, Ill.

Personals.

Mr. William Robbins McGovern has been appointed Chief Engineer of the Wisconsin Telephone Company.

Messrs. Emmet T. Bowen, Clark M. Knight and Joseph E. Davis have organized the Knight & Bowen Construction Co., of Madison, Wis.

Mr. S. Bent Russell, Mem. Am. Soc. C. E., has returned to St. Louis, Mo., for permanent headquarters. His engineering offices will be at 415 Locust street.

Mr. Frank T. Darrow has been appointed Engineer of Maintenance of Way of the Chicago, Burlington & Quincy Ry., succeeding Mr. I. S. P. Weeks, deceased.

Mr. Walter E. Snow, Mem. Am. Soc. M. E., Publicity Engineer, of Boston, Mass., has been appointed a member of the Massachusetts Commission for the Blind.

Mr. H. H. Woodmon has been appointed Chief Engineer of the Missouri Southern R. R., succeeding Mr. G. W. Payne, whose resignation went into effect on Nov. 15.

Messrs. Thomas J. Lindley, William O. Sweeney, Patrick H. Sweeney and Claude T. Lindley have organized the W. O. Sweeney Co., of Jeffersonville, Ind., and will engage in a general contracting business.

Mr. F. M. Hill has resigned his position as Engineer for the Reinforced Concrete Pipe Co., of Jackson, Mich., and has become Consulting Engineer for the J. J. Newnan Lumber Co., of Hattiesburg, Miss.

Ellyson Gwyn, a civil engineer of Memphis, Tenn., died Nov. 7 at the Presbyterian Hospital in that city. Mr. Gwyn had been connected with government work, and was taken ill while superintending the construction of a levee near Caruthersville, Mo.

Mr. G. S. Leavenworth, for the past five years Chief Engineer for Powers & Mansfield Co., Troy, N. Y., has removed to Burlington, Vt., to take an active interest in the Vermont Construction Co., of which he is a director and stockholder. He will also do consulting engineering work.

Richard W. Gorrill, a retired contractor of Oakland, Cal., died November 9 at Rhyolite, Nev., where he had gone for his health. Mr. Gorrill for several years was President of the Pacific Bridge Co. He erected the Ferry building in San Francisco and the Modesto and Turlock Irrigation Project dam at La Grange. He retired from the construction business in 1898.

James McGraw, President of the James McGraw Co., contractors, Philadelphia, Pa., died Nov. 3 at his home in that city, after an illness of eight weeks. Mr. McGraw was born at Downingtown, Pa., about 50 years ago, and began his business life as a member of the engineer corps of the Pennsylvania R. R. In the late seventies he started in business on his own account as a contractor. His first contract was in building the Frazer branch of the Pennsylvania R. R. Since then he has constructed many other lines, notably

the Petersburg branch of the same railroad. His company has also had large contracts for the Philadelphia & Erie R. R., and built the short line to New York for the Reading. The concern is now engaged in building the Reading elevated on Ninth street and that of the Pennsylvania on Traction avenue, in Philadelphia. Mr. McGraw also constructed the "jump over" at Winslow Junction for the West Jersey R. R.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0974. **Industrial and Light Railways.**—Arthur Koppel Co., Pittsburg, Pa.

This new 56-page catalog of the above named company is intended to convey a comprehensive idea of the line of portable, industrial and narrow gauge railways and their equipment which is handled by the company. One of the interesting facts mentioned is that the company's engineers are available to interested purchasers to work out complete plans for railways of the kind named for all purposes. This consulting service is of the highest technical quality. The descriptive text of the catalog is good and the illustrations are clear and instructive.

No. 0975. **Buckets.**—The Brown Hoisting Machinery Co., Cleveland, O.

This handsome 54-page catalog covers thoroughly the well known product of this company in this line. "Brownhoist" grab buckets for handling coal, ore, limestone, etc., are fully described and illustrated. The two rope buckets are pictured in use on many different types of machines. The "Brownhoist" single rope buckets for use on existing machines, having but a single drum engine, are also described and pictured. Automatic dumping tubs, shovel buckets, etc., are also shown.

No. 0976. **Graphite and Grease.**—International Graphite Co., Niagara Falls, N. Y.

This 8-page circular describes the nature and explains the advantages of the special graphite and grease lubricating compound made by the company named. The compound is made in several compositions for gears, gears and cups, ball bearings, etc.

No. 0977. **Concrete Blocks, Pipes and Ornaments.**—Miracle Pressed Stone Co., Minneapolis, Minn.

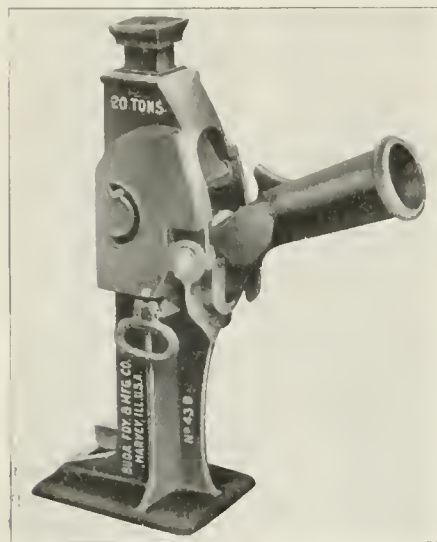
This 142-page elaborately illustrated catalog describes and pictures the full line of block and brick machines and general and special molds for cast concrete work which is handled by the company named. There are shown machines and molds for building blocks and brick, sewer pipes, culverts, sills, columns and ornamental shapes of various patterns. Pictures of the blocks and other products are shown and also views and plans of concrete block buildings. The great feature of the book is the directions and descriptions it gives of methods of operation of machines and molds and of manufacturing cast concrete. Concrete mixers, block cars, centers for concrete, engines, screens and cement workers' tools are also illustrated and described.

No. 0978. **Gas Machines.**—Matthews Gas Machine Co., Chicago, Ill.

This 22-page pamphlet gives a large amount of useful information regarding the principle of operation and the construction of gasoline gas machines for illumination, cooking, etc. It also describes in detail the gas machines made by the company named, which are claimed to do away entirely with variation in the quality of the gas. The pamphlet should be had by anyone required to install isolated lighting plants for domestic, factory or other service.

No. 0979. **Jacks.**—The Buda Foundry & Mfg. Co., Chicago, Ill.

This 83-page pamphlet catalogues the full line of jacks made by the company named, including the new line of high power ratchet jacks. Particular mention may be made of the single acting ratchet jack of 20-ton capacity. This machine has several interesting and important features.



Buda Ratchet Jack.

der full load. These limitations are overcome in this new style jack. The jack is equipped with special pawls which have triple teeth. It will be seen, therefore, that the full capacity is distributed over three teeth in the rack, producing a strain of less than 7 tons on each of the teeth. As it has been shown that a tooth will tend to upset at 15 tons, a safety factor is here shown of fully 100 per cent.

Another feature of importance is an extra large fulcrum pin of high carbon steel, tempered and ground. The shearing tendency ordinarily present has been reduced by an unique design of the bearing. The lower half of the lever, through which the pin extends, is fashioned to contain a shoulder. The bushing around the pin extends through the frame and on to the shoulder of the lever, thus supporting the fulcrum pin between the lever and the frame. A special design of the pawls was also necessary to accomplish the engagement of the triple teeth at all times. This has been suc-

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Nov. 25. Richmond, Va.....	Nov. 11
Nov. 25. Pittsburgh, Pa.....	Nov. 11
Nov. 30. Lepreau, N. B.....	Nov. 4
Dec. 2. Greenville, S. C.....	Nov. 25
Dec. 2. Chicago, Ill.....	Nov. 25
Dec. 4. Milwaukee, Wis.....	Nov. 18
Dec. 5. Wichita, Kan.....	Nov. 4
Dec. 7. Grenada, Miss.....	Nov. 11
Dec. 7. Valparaiso, Ind.....	Nov. 25
Dec. 7. Kansas City, Mo.....	Nov. 25
Dec. 7. Kansas City, Kan.....	Nov. 25
Dec. 7. Los Angeles, Cal.....	Nov. 25
Dec. 8. Paoli, Ind.....	Nov. 18
Dec. 8. Princeton, Ind.....	Nov. 25
Dec. 14. Green Bay, Wis.....	Nov. 25
Dec. 16. Columbus, O.....	Nov. 18
Dec. 16. Columbus, O.....	Nov. 25

Buildings.

Nov. 25. Hazelton, Pa.....	Oct. 28
Nov. 25. Oakland, Cal.....	Nov. 11
Nov. 25. Brooklyn, N. Y.....	Nov. 18
Nov. 27. Milford, Del.....	Oct. 28
Nov. 27. Cincinnati, O.....	Nov. 11
Nov. 27. Providence, R. I.....	Nov. 18
Nov. 28. Prescott, Ariz.....	Nov. 18
Nov. 28. National Military Home, Kan.....	Nov. 25
Nov. 30. Manchester, Va.....	Oct. 28
Nov. 30. New York, N. Y.....	Nov. 18
Nov. 30. St. Joseph, Mo.....	Nov. 18
Nov. 30. New York, N. Y.....	Nov. 25
Nov. 30. New York, N. Y.....	Nov. 25
Nov. 30. Washington, D. C.....	Nov. 25
Nov. 30. Phoenix, Ariz.....	Nov. 25
Dec. 1. Newton, Kan.....	Oct. 28
Dec. 1. Washington, D. C.....	Nov. 11
Dec. 1. Fort Hamilton, N. Y.....	Nov. 18
Dec. 1. West Orange, N. J.....	Nov. 25
Dec. 1. Carlisle, Pa.....	Oct. 28
Dec. 1. Canton, N. Y.....	Nov. 18
Dec. 1. New York, N. Y.....	Nov. 25
Dec. 1. New York, N. Y.....	Nov. 25
Dec. 1. Richmond, Va.....	Nov. 25
Dec. 1. Lebanon, Ind.....	Oct. 28
Dec. 1. Denver, Colo.....	Nov. 18
Dec. 7. Covington, Ky.....	Nov. 25
Dec. 7. Wheeling, W. Va.....	Nov. 25
Dec. 8. Gainesville, Ga.....	Nov. 4
Dec. 8. Industry, N. Y.....	Nov. 25
Dec. 9. Columbus, O.....	Nov. 25
Dec. 10. Wausau, Wis.....	Nov. 18
Dec. 14. Fort Meade, S. Dak.....	Nov. 25
Dec. 16. San Jose, Cal.....	Nov. 25
Dec. 18. Madison, Wis.....	Nov. 18
Dec. 21. Seattle, Wash.....	Nov. 18
Dec. 22. Coldwater, Mich.....	Nov. 18
Dec. 26. Americus, Ga.....	Nov. 25
Dec. 28. Lake Charles, La.....	Nov. 25
Dec. 29. Alton, Ill.....	Nov. 25
Jan. 4. Sault Ste. Marie, Mich.....	Nov. 25
Jan. 5. Niles, Mich.....	Nov. 25

Roads and Streets.

Nov. 25. Uniontown, Pa.....	Nov. 11
Nov. 25. Elkhart, Ind.....	Nov. 18
Nov. 25. Brooklyn, N. Y.....	Nov. 18
Nov. 27. Cincinnati, O.....	Nov. 11
Nov. 27. Columbus, O.....	Nov. 11
Nov. 27. Cincinnati, O.....	Nov. 11
Nov. 28. Hillsdale, N. J.....	Nov. 18
Nov. 30. Avalon, Pa.....	Nov. 25
Nov. 30. Houston, Tex.....	Nov. 25

Nov. 30. Muskogee, Okla.....	Nov. 25
Nov. 30. Kansas City, Mo.....	Nov. 25
Nov. 30. Lewiston, Idaho.....	Nov. 25
Dec. 1. Ashland, O.....	Nov. 25
Dec. 1. New York, N. Y.....	Nov. 25
Dec. 2. Bryan, O.....	Nov. 25
Dec. 2. Brooklyn, N. Y.....	Nov. 25
Dec. 3. Kansas City, Mo.....	Nov. 25
Dec. 4. Olympia, Wash.....	Nov. 25
Dec. 4. Peru, Ind.....	Nov. 25
Dec. 7. Vernon, Ind.....	Nov. 18
Dec. 7. Denver, Colo.....	Nov. 18
Dec. 7. Kansas City, Kan.....	Nov. 25
Dec. 7. Greenfield, Ind.....	Nov. 25
Dec. 7. Delphi, Ind.....	Nov. 25
Dec. 7. Decatur, Ind.....	Nov. 25
Dec. 7. Crown Point, Ind.....	Nov. 25
Dec. 7. Crawfordsville, Ind.....	Nov. 25
Dec. 7. Columbus, Ind.....	Nov. 25
Dec. 7. Wabash, Ind.....	Nov. 18
Dec. 8. Vincennes, Ind.....	Nov. 25
Dec. 8. Spencer, Ind.....	Nov. 25
Dec. 8. Madison, Ind.....	Nov. 25
Dec. 8. Bedford, Ind.....	Nov. 25
Dec. 9. Salem, N. J.....	Nov. 25
Dec. 9. Muncie, Ind.....	Nov. 25
Dec. 9. Corydon, Ind.....	Nov. 25
Dec. 11. Mt. Vernon, Ind.....	Nov. 25
Dec. 12. Purrell, Okla.....	Nov. 25
Dec. 12. Fort Riley, Kan.....	Nov. 25
Dec. 17. Newton, N. J.....	Nov. 25
Dec. 21. St. Paul, Minn.....	Nov. 25
Dec. 23. Cleveland, O.....	Nov. 25

Sewers.

Nov. 25. Chicago, Ill.....	Nov. 18
Nov. 25. Binghamton, Tenn.....	Nov. 18
Nov. 25. Indianapolis, Ind.....	Nov. 18
Nov. 27. Toledo, O.....	Nov. 25
Nov. 27. Duluth, Minn.....	Nov. 25
Nov. 27. Salt Lake City, Utah.....	Nov. 25
Nov. 27. Dayton, O.....	Nov. 25
Nov. 30. Washington, D. C.....	Nov. 18
Dec. 1. Guayaquil, Ecuador.....	Oct. 7
Dec. 1. Trenton, N. J.....	Nov. 18
Dec. 2. Steubenville, O.....	Nov. 25
Dec. 2. Bennettsville, S. C.....	Nov. 25
Dec. 2. Brooklyn, N. Y.....	Nov. 25
Dec. 3. Cambridge, O.....	Nov. 25
Dec. 4. Wooster, O.....	Nov. 25
Dec. 7. Muskegon, Mich.....	Nov. 18
Dec. 7. Los Angeles, Cal.....	Nov. 25
Dec. 8. Hobart, Okla.....	Nov. 25
Dec. 15. Toronto, Ont.....	Nov. 25

Water Supply.

Nov. 25. Chicago, Ill.....	Nov. 18
Nov. 27. Parkersburg, W. Va.....	Nov. 25
Dec. 1. Wilton, Wis.....	Nov. 18
Dec. 1. Yorkville, Ill.....	Nov. 18
Dec. 2. Covington, Ga.....	Nov. 18
Dec. 8. Meridian, Miss.....	Nov. 18
Dec. 8. Amsterdam, N. Y.....	Nov. 25
Dec. 8. Moundridge, Kan.....	Nov. 25
Dec. 14. Gridley, Cal.....	Nov. 18
Dec. 21. Astoria, Ore.....	Nov. 25

Miscellaneous.

Nov. 27. Michipicoten, Ont.,	Wharf, Nov. 4
Nov. 27. Three Rivers, Que.,	Dock and Ice Breaker, Nov. 11
Nov. 27. Tampa, Fla.,	Street Lighting, Nov. 18
Nov. 27. Washington, D. C.,	Wharf, Nov. 18
Nov. 28. St. Louis, Mo.,	Dry Dock, Oct. 28
Nov. 30. Lepreau, N. B.,	Retaining Wall, Nov. 11
Nov. 30. Cheyenne, Wyo.,	Concrete Dam, Nov. 25
Dec. 1. Fort Robinson, Neb.,	Electric Light System, Etc., Nov. 11
Dec. 1. New York, N. Y.,	Aqueduct, Nov. 18
Dec. 2. Fort Sam Houston, Tex.,	Electric Light Line Extension, Nov. 11
Dec. 3. New York, N. Y.,	Metal Storage Cabinets, Nov. 25
Dec. 4. Niagara Falls, N. Y.,	Tunnel, Elevators, Etc., Nov. 18
Dec. 7. Clinton, N. C.,	Dam, Nov. 25
Dec. 9. Flathead, Mont.,	Saw and Grist Mill, Nov. 18
Dec. 10. Ottawa, Ont.,	Steamer, Nov. 18
Dec. 10. Memphis, Tenn.,	Street Lighting, Nov. 25
Dec. 11. Cincinnati, O.,	Power House, Nov. 18
Dec. 12. Chicago, Ill.,	Pile Pier, Nov. 4
Dec. 15. Washington, D. C.,	Steam Collier, Nov. 4
Dec. 16. San Jose, Cal.,	Power Plant, Etc., Nov. 25
Dec. 22. Jefferson Barracks, Mo.,	Electric Lighting System, Nov. 25
Jan. 4. Hartford, Conn.,	Street Lightning, Nov. 18

Excavation, Earth and Rock

Nov. 30. Los Angeles, Cal.,	Ditch Work, Oct. 21
Dec. 1. Hawaii,	Dredging, Sept. 28
Dec. 1. Tiffin, O.,	Rock Excavation, Nov. 18
Dec. 4. Springfield, Mass.,	Earth Dam, Nov. 18
Dec. 9. Savannah, Ga.,	Dredging, Nov. 18
Dec. 9. Boston, Mass.,	Dredging, Nov. 25
Dec. 11. Eldora, Ia.,	Drainage Work, Nov. 25
Dec. 12. San Francisco, Cal.,	Dredging, Nov. 25
Dec. 14. Peoria, Ill.,	Tile Drains, Nov. 18
Dec. 22. Estherville, Ia.,	Ditch, Nov. 18
Jan. 9. Anoka, Minn.,	Ditch Work, Nov. 25

Materials, Machines, Supplies, Tools, Etc.

Nov. 25. Columbus, O.,	Transformers, Etc., Nov. 18
Nov. 27. Grand Rapids, Mich.,	Sewage Pumping Machinery, Nov. 11
Nov. 27. Washington, D. C.,	Steel Dump Cars, Nov. 11
Nov. 27. Duluth, Minn.,	Fire Hose, Nov. 25
Nov. 28. Denver, Colo.,	Freight Lift, Nov. 11
Nov. 28. Chicago, Ill.,	Street Flushing Machines, Nov. 18
Nov. 28. Milwaukee, Wis.,	Teas, Bonds, Etc., Nov. 25
Nov. 30. Atlanta, Ga.,	Motor, Nov. 11
Nov. 30. Washington, D. C.,	Boilers, Tanks, Drills, Etc., Nov. 18
Nov. 30. Los Angeles, Cal.,	Teas, Bonds, Etc., Nov. 18
Nov. 30. National Military Home, Kan.,	Dry Clearing Plant, Nov. 25
Nov. 30. Washington, D. C.,	Flooring Timber, Nov. 25
Dec. 1. Edmonton, Alberta,	Granite, Nov. 18
Dec. 1. Chicago, Ill.,	Lumber, Nov. 25
Dec. 1. Norfolk, Va.,	Valves, Nov. 25
Dec. 1. Norfolk, Va.,	Portland Cement, Nov. 25
Dec. 1. Greenville, Tex.,	Pipe, Specials, Valves, Nov. 25
Dec. 1. New Orleans, La.,	Fire Hose, Nov. 25
Dec. 3. Grand Rapids, Mich.,	Water Meters, Nov. 25
Dec. 3. New York, N. Y.,	Crabstones, Nov. 25
Dec. 7. Grand Forks, N. Dak.,	Fire Hose, Nov. 18
Dec. 7. Washington, D. C.,	Locomotives, Nov. 18
Dec. 7. Fort Leavenworth, Kan.,	Ballast, Nov. 25
Dec. 8. Meridian, Miss.,	Pumping Machinery, Nov. 18
Dec. 9. Washington, D. C.,	Towing Machines, Nov. 18
Dec. 14. Washington, D. C.,	Boilers, Generators, Rope, Etc., Nov. 25

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Los Angeles, Cal.—Until 2 p. m., Dec. 7, by C. G. Keyes, Clerk County Supervisors, for labor and materials necessary for the construction of a reinforced concrete bridge over Santa Anita Wash. on White Oak Ave. in the Lamanda Road District.

Chicago, Ill.—Until noon, Dec. 2, by Trustees Sanitary District of Chicago, I. J. Bryan, Clerk, American Trust Bldg., for the fabrication, erection and completion of the superstructure of a railroad bridge at the crossing of the Chicago, Milwaukee & St. Paul Rv. over the North Shore Channel of the Sanitary District of Chicago, near Chancellor St., Evanston.

Parli, Ind.—Until 2 p. m., Dec. 8, by A. B. Ham, County Auditor, for constructing 21-ft. span steel leg bridge.

Kansas City, Kan.—Until Dec. 7, by County Commissioners for constructing reinforced concrete culvert on the Mastin Road.

Kansas City, Mo.—Until Dec. 7, by Commercial Improvement Co., 220 Dwight Bldg., Kansas City, for manufacture and erection of

steel superstructure and concrete footings of viaduct on Main St.

Columbus, O.—As stated in our last issue, bids are being asked by the Board of Public Service, E. W. Hirsch, Secretary, for constructing approaches and substructure of Mound St. viaduct. The work includes: Excavation, 8,100 cu. yds.; concrete, class A (parapet wall), 2,740 lin. ft.; concrete, class B, 16,500 cu. yds.; concrete, class C, 4,500 cu. yds.; sandstone masonry, class A, 1,700 cu. yds.; sandstone masonry, class B, 2,450 cu. yds.; sandstone masonry, class C, 2,690 cu. yds.; sandstone coping, class D, 2,740 lin. ft.; limestone wheel course, 64 lin. ft.; waterproofing, 235 squares; embankment, 6,850 cu. yds.; crushed stone for roadway surface, 300 tons.

Columbus, O.—Until noon, Dec. 16, by Board Public Service, E. W. Hirsch, Secretary, for furnishing the labor and material for building and erecting the steel superstructure of a viaduct over the tracks of the Hocking Valley and Toledo and Ohio Central Rys. on Mound St. Total estimated weight of steel superstructure is 293 tons.

Greenville, S. C.—J. P. Goodwin, County Supervisor, will let contracts for building new wood bridges at the following sites: Hopkins bridge, Dec. 2, at 11 a. m.; Slaten's Mill bridge, Dec. 2, at 12 a. m.; Lattimer's Mill bridge, Dec. 3, at 2 p. m.; Scott's Mill bridge, Dec. 3, at 10 a. m.

Green Bay, Wis.—Until 2 p. m., Dec. 14, by City Clerk, for the construction of a bridge over Fox River at Walnut St. to consist of four 140-ft. fixed spans, one movable span (bascule), 114 ft. Plans, etc., with Strauss Reinforced Concrete & Bascule Bridge Co., 903 Fort Dearborn Bldg., Chicago. W. W. Reed, City Engineer, Green Bay, Wis.

Milwaukee, Wis.—Until 10:30 a. m., Dec. 4, by Board Public Works, Charles J. Poetsch, Chairman, for constructing a bascule bridge across the Milwaukee River, at the foot of East Water St. Certified check for \$25,000 required with bid.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Phoenix, Ariz.—Until 5 p. m., Nov. 30, by Frank Thomas, City Recorder, for furnishing and setting up in place and connecting the boiler, radiators, pipes, valves and fittings, necessary to perfect a low pressure hot water heating apparatus for the City Hall of Phoenix.

San Jose, Cal.—Until 4 p. m., Dec. 16, by W. M. Southeimer, Secretary Board of Managers, for erection of a superintendent's residence at Agnews State Hospital. Selton & Hemmings, State Architects, 244 Kearney St., San Francisco, Cal.

Washington, D. C.—Until 2 p. m., Nov. 30, by District Commissioners, for furnishing switch boards, conduits and cables for use in McKinley Manual Training School.

Americus, Ga.—Until 3 p. m., Dec. 26, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction, including plumbing, heating apparatus, electric conduits and wiring, of the U. S. Post Office at Americus.

Lake Charles, La.—Until 3 p. m., Dec. 28, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction, including plumbing, gas piping, heating apparatus, electric conduits and wiring, of the U. S. Post Office and Court House at Lake Charles.

Alton, Ill.—Until 3 p. m., Dec. 29, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction, including plumbing, gas piping, heating apparatus, electric conduits and wiring, of the U. S. Post Office at Alton.

National Military Home, Kan.—Until noon, Nov. 28, by Major W. W. Martin, Treasurer, Western Branch, N. H. D. V. S., National Military Home, for furnishing material and labor for an addition to hospital.

Covington, Ky.—Until noon, Dec. 7, by Trustees Library, Jno. J. Craig, President, for alterations to auditorium of Covington Library Building. Work will include excavation, concrete footings and limestone masonry, brick masonry, cement floors, low pressure steam heating system, etc. Dittoe & Wisenall, Architects, 75 Blymer Bldg., Cincinnati, O.

Niles, Mich.—Until 3 p. m., Jan. 5, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction, including plumbing, gas piping, heating apparatus, electric conduits and wiring, of the U. S. Post Office at Niles.

Saulte Sainte Marie, Mich.—Until 3 p. m., Jan. 4, by James Knox Taylor, Supervising

Architect, Washington, D. C., for the construction complete, except elevator, of the U. S. Post Office at Sault Sainte Marie.

West Orange, N. J.—Until Dec. 1, by F. L. Baldwin, District Clerk, for construction of an addition to the Washington school building.

Industry, N. Y.—Until 7 p. m., Dec. 8, by Miss Lura E. Aldridge, President of the Board of Managers, New York State Agricultural and Industrial School, Industry, N. Y., for construction complete, including heating, plumbing and electric work for addition to Industrial Building, Hospital for Contagious Diseases, four cottages for boys and five cottages for employees, at New York State Agricultural and Industrial School, Industry, Franklin B. Ware, State Architect, Albany, N. Y.

New York, N. Y.—Until 2:30 p. m., Nov. 30, by Robert W. Heberd, Commissioner Public Charities, for construction and entire completion of a tuberculosis infirmary for the Metropolitan Hospital District, Blackwells Island.

New York, N. Y.—Until 2 p. m., Dec. 3, by J. W. Stevenson, Commissioner of Bridges, 13 Park Row, for construction of foundations for new municipal building.

New York, N. Y.—Until 3 p. m., Nov. 30, by John W. Brannan, President Board of Trustees, Bellevue and Allied Hospitals, for the excavating, piling, mason, fireproofing, waterproofing, carpenter, steel, electric, heating and ventilating, plumbing and other work for the boiler house and coaling station of the new Bellevue Hospital, situated on First Ave. and bounded by 26th and 27th Sts.

New York, N. Y.—Until 2:30 p. m., Dec. 2, by Robert W. Heberd, Commissioner of Charities, for the complete conduiting, electric wiring and all other work in connection with the installation of a complete electric lighting and power system for certain of the buildings and grounds under the jurisdiction of the Department of Public Charities, and included in the Metropolitan Hospital District, Blackwells Island.

Columbus, O.—Until noon, Dec. 9, by Board Trustees of Ohio State University, Carl E. Steeb, Secretary, for material and labor for erection of following buildings at Ohio State University: (1) a students' building; George S. Mills, Architect, Toledo, O., and (2) a veterinary clinic building; Richards, McCarty & Bulford, Architects, Columbus.

Richmond, Va.—Until 5 p. m., Dec. 3, by Chas. E. Bolling, City Engineer, for installing heating plant at City Auditorium.

Richmond, Va.—Until 6 p. m., Dec. 3, by H. P. Beck, Building Inspector, for the construction of a market and armory building for the city. Averill, Hall & Adams, Architects, 719 Union Trust Bldg., Washington, D. C.

Wheeling, W. Va.—Until 3 p. m., Dec. 7, by James Knox Taylor, Supervising Architect, Washington, D. C., for alterations to the 12th St. entrance at the U. S. Post Office, Custom House and Court House Building, Wheeling.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Lewiston, Idaho.—Until 8 p. m., Nov. 30, by Jno. E. Nickerson, City Clerk, for the construction of a drainage system, combined curbs and gutters, and about 54,000 sq. yds. of bitulithic pavement.

Bedford, Ind.—Until 1 p. m., Dec. 8, by Walter G. Owens, County Auditor, for constructing 10,450 ft. of gravel or macadamized roadway.

Columbus, Ind.—Until 10 a. m., Dec. 7, by John M. Davis, County Auditor, for constructing 10,770 ft. of macadam road in Clay Township.

Corydon, Ind.—Until 2 p. m., Dec. 9, by Frank E. Watson, County Auditor, for constructing gravel or macadamized road in Spencer Township, and a similar road in Jackson Township.

Crawfordsville, Ind.—Until 10 a. m., Dec. 7, by B. B. Engle, County Auditor, for improvement of a gravel road.

Crown Point, Ind.—Until noon, Dec. 7, by Charles A. Johnson, County Auditor, for constructing gravel road in North Township.

Decatur, Ind.—Until 10 a. m., Dec. 7, by C. D. Lewton, County Auditor, for constructing seven macadam roads.

Delphi, Ind.—Until noon, Dec. 7, by M. G. Haun, County Auditor, for constructing two gravel roads.

Greenfield, Ind.—Until 10 a. m., Dec. 7, by

Chas. H. Troy, County Auditor, for improvement of public highway.

Madison, Ind.—Until 1 p. m., Dec. 8, by G. F. Crozier, County Auditor, for the improvement of 6.64 miles of roadway.

Mt. Vernon, Ind.—Until 2 p. m., Dec. 11, by Paul Maler, County Auditor, for improvement of five roads (about 8 miles in all) by grading and macadamizing.

Muncie, Ind.—Until 10 a. m., Dec. 9, by J. E. Davis, County Auditor, for the following work: Improvement of public highway in Delaware Township; two public highways in Center Township, one highway in Mount Pleasant Township, and two highways in Liberty Township.

Peru, Ind.—Until noon, Dec. 4, by Commissioners of Cass and Miami Counties, for constructing joint county gravel road. George Cann, Auditor, Cass County.

Spencer, Ind.—Until noon, Dec. 8, by Geo. W. Edwards, County Auditor, for constructing gravel road 15,300 ft. long in Montgomery Township, gravel road 12,500 ft. long in Jefferson Township, macadamized road 15,800 ft. long in Washington Township and a macadamized road 9,300 ft. long in Franklin Township.

Vincennes, Ind.—Until 2 p. m., Dec. 8, by John D. Scott, County Auditor, for constructing two gravel roads—1,300 ft. and 3,200 ft. long.

Fort Riley, Kan.—Until 10 a. m., Dec. 14, by Capt. W. M. Whitman, Constructing Q. M., for construction of macadam roads, curbing and guttering, catch basins and grading at this post.

Kansas City, Kan.—Until Dec. 7, according to reports, by County Commissioners, for the following work: Resurfacing Shawnee Road from Hester Road to Steele Road in Shawnee Township; macadamizing Gibb Road from end of present macadam to county line; macadamizing De Fries Road from U. P. Ry. crossing west for one mile; resurfacing Southwest Boulevard from Rosedale City limits to intersection of Proebstel Road.

St. Paul, Minn.—Until Dec. 21, by E. G. Krahmer, County Auditor, for improvement of Bald Eagle Lake Ave. by macadamizing or graveling.

Kansas City, Mo.—Until 11 a. m., Dec. 3, by J. L. Darnell, City Engineer, for two contracts for paving with brick, two contracts for asphalt, one contract for repairing asphalt pavement, and 12 contracts for grading.

Kansas City, Mo.—Until 3 p. m., Nov. 30, by Frank P. Gossard, Secretary Park Commissioners, for paving portion of Valentine Road.

Newton, N. J.—Until noon, Dec. 17, by Loren E. Cole, Director County Freeholders, for grading and macadamizing about 10 miles of road. A. H. Konkle, County Engineer, Newton, N. J.

Salem, N. J.—Until 10:30 a. m., Dec. 9, by John F. Ayars, County Road Director, for grading and placing gravel surface on 3.31 miles of road. Howard B. Keasbey, Engineer, Mecum Bldg., Salem.

Brooklyn, N. Y.—Until 11 a. m., Dec. 2, by Bird S. Coler, Borough President, for improvement of several streets by regulating and repaving with asphalt and granite on a concrete foundation, the roadways of certain streets; also for regulating, curbing, grading and laying sidewalks in various streets.

New York, N. Y.—Until 11 a. m., Dec. 1, by Louis F. Haffen, President of Bronx Borough, for the improvement of several streets by paving and repaving with asphalt blocks on a concrete foundation, the roadways of various streets. Bids are also asked for regulating, grading, setting curb stones, flagging the sidewalks, laying crosswalks and building approaches.

Ashland, O.—Until noon, Dec. 1, by County Commissioners, for grading and macadamizing about 1.5 miles of road in Vermillion Township. Estimated cost is \$9,090. Plans, etc., with County Commissioners at Ashland and with James C. Wonders, State Highway Commissioner, Columbus, O.

Bryan, O.—Until noon, Dec. 2, by County Commissioners, for grading and macadamizing 1.26 miles of road in Springfield Township, estimated to cost \$6,993. Plans, etc., with County Commissioners at Bryan, and with James C. Wonders, State Highway Commissioner, Columbus.

Cleveland, O.—Until 11 a. m., Dec. 23, by County Commissioners, William F. Black, Clerk, for the improvement of Royalton Road from Bennet Road to a point 500 ft. west of A. Rimke's east line in Royalton Township.

Muskogee, Okla.—Until 5 p. m., Nov. 30, by L. B. Kinsey, City Engineer, for 14,000 sq. yds. of asphalt paving.

Purcell, Okla.—Until Dec. 12, by R. L. Mc-

Willie, City Engineer, for constructing brick pavement.

Avalon, Pa.—Until 5 p. m., Nov. 30, by M'Bridge Surveying & Engineering Co., Ltd., Borough Engineer, 708 Fitzsimons Bldg., Pittsburgh, Pa., for constructing 590 lin. ft. of curbing on West Division St.

Houston, Tex.—Until Nov. 30, by City Clerk, for paving San Jacinto St., from McKinney to Leeland Ave.; Preston from Crawford to the International and Great Northern tunnel and Dowling from Congress to Preston Sts.

Olympia, Wash.—Until 2 p. m., Dec. 4, by State Highway Board, for work on State Aid Road No. 27.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Los Angeles, Cal.—Until 2 p. m., Dec. 7, C. G. Keyes, Clerk County Supervisors, for the construction of a storm drain, catch basins, manholes and combination cement gutter and curb, on Ocean Ave. and Adilaide Drive in Santa Monica and partly in the Santa Monica Road District. Bids are asked on (1) a 30-in. brick storm drain; (2) a 30-in. pipe storm drain, using 30-in., first quality, double strength, vitrified, salt-glazed sewer pipe.

Duluth, Minn.—Until 10 a. m., Nov. 27, by Board Public Works, R. Murchison, Clerk, for constructing several sewers.

Brooklyn, N. Y.—Until Dec. 2, by Bird S. Coler, Borough President, for constructing sewer in East 98th St.

Cambridge, O.—Until noon, Dec. 3, by Board Public Service, O. M. Hoge, City Engineer, for labor and materials for constructing sewers in parts of Highland and Wall Aves., the work including 1,000 ft. 8-in., and 600 ft. 4-in. pipe.

Dayton, O.—Until noon, Nov. 27, by Board Public Service, W. A. Budroe, Clerk, for constructing sanitary sewers in part of District No. 9, the work including 3,800 lin. ft. 8-in. vitrified pipe. Also for the construction of storm water sewer on Kemp St., the work including 340 lin. ft. of 24-in. pipe sewer (double strength); 320 lin. ft. of 18-in. pipe sewer (double strength); 160 lin. ft. of 15-in. pipe sewer, and 250 lin. ft. of 12-in. pipe sewer.

Steubenville, O.—Until noon, Dec. 2, by Board Public Service, G. Simpson, Clerk, for constructing vitrified pipe sewer in Grandview Ave. Certified check for \$200 required with bid.

Toledo, O.—Until noon, Nov. 27, by Board Public Service, Reynold Voit, Secretary, for constructing a sewer.

Wooster, O.—Until noon, Dec. 4, by Board Public Service, C. M. Vannest, Clerk, for constructing sewer in South Buckeye St. Certified check for \$200 required with bid.

Hobart, Okla.—Until 8 p. m., Dec. 8, by Jesse Field, City Clerk, for furnishing material and constructing an extension to sanitary sewer system of city, the work including: 910 ft. of 12-in. concrete or vitrified clay pipe, 1,900 ft. of 10-in. concrete or vitrified clay pipe, 13,080 ft. of 8-in. concrete or vitrified clay pipe, 31 manholes, 6 flush tanks. O. E. Noble, City Engineer. Official advertisement elsewhere in this issue.

Bennettsville, S. C.—Until 2 p. m., Dec. 2, by Sewer Commission, T. E. McCall, Chairman, for labor and material for constructing sanitary sewer system to consist of about six miles of 8 to 15-in. vitrified pipe sewer. Bandy & Myers, Engineers, Greensboro, N. C.

Salt Lake City, Utah.—Until 8 p. m., Nov. 27, by Board Public Works, L. C. Kelsey, City Engineer, for constructing sewer extensions No. 208.

Toronto, Ont.—Until noon, Dec. 15, by Mayor Joseph Oliver, Chairman of the Board of Control, City Hall, for the construction of Sec. 3 of the high level intercepting sewer, the work including: 1,971 lin. ft. of 7-ft. 6-in. circular sewer, 2,417 lin. ft. of 7-ft. 9-in. circular sewer, 1,557 lin. ft. of 8-ft. circular sewer, 440 lin. ft. of 8-ft. 6-in. circular sewer, together with manholes, connections, etc.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Moundridge, Kan.—Until Dec. 8, by Mayor E. E. Lehmborg for constructing water works and electric light plant. Burns & McDonnell, Engineers, Scaritt Bldg., Kansas City, Mo.

Meridian, Miss.—Plans and specifications for a reinforced concrete reservoir to be con-

structed for this city are on file at office of Engineering-Contracting, 355 Dearborn St., Chicago, Ill. Bids are asked until Dec. 8, as stated in our last issue. The work includes 805 cu. yds. concrete, 7,380 concrete blocks, 1,450 cu. yds. excavation, 2,464 cu. yds. embankment and 93,900 lbs. steel bars. W. F. Wilcox, Engineer.

Amsterdam, N. Y.—Until 8 p. m., Dec. 8, by Board of Water Commissioners, Charles C. Yund, President, for hauling and delivering cast iron pipe and constructing pipe line (Hans Creek Conduit No. 2). James R. Snell, Superintendent of Water Works.

Astoria, Ore.—Until noon, Dec. 21, by Water Commission, C. S. Wright, Chairman, for material and constructing about 12,000 ft. of 24-in. concrete water pipe and 1,300 ft. of steel water pipe. Official advertisement will be found elsewhere in this issue.

Parkersburg, W. Va.—Until Nov. 27, by Board of Affairs, Frank Good, City Auditor, for material and labor for constructing 7,650 ft. 6-in. water pipe in the 8th Ward, and 2,130 ft. of 8-in. pipe in 2nd, 3rd and Green Sts.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

San Francisco, Cal.—Dredging.—Until Dec. 12, by Lt. Col. John Biddle, U. S. Engrs., for dredging in Oakland Harbor, California.

Eldora, Ia.—Drainage Work.—Until 9 a. m., Dec. 11, by R. A. Vigars, County Auditor, for construction of ditch and tile drains in Franklin-Hardin Drainage District No. 1. Open ditch work requires 45,900 cu. yds. excavation.

Boston, Mass.—Dredging.—Until noon, Dec. 9, by Lt.-Col. Edward Burr, U. S. Engrs., for dredging in Essex River, Massachusetts.

Anoka, Minn.—Ditch Work.—Until 11 a. m., Jan. 9, by A. A. Caswell, County Auditor, for constructing Ditch No. 49, requiring 83,000 cu. yds. excavation and estimated to cost \$12,975.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

San Jose, Cal.—Power Plant, Etc.—Until 4 p. m., Dec. 16, by W. M. Southeimer, Secretary Board of Managers, Agnews State Hospital, 7 W. Santa Clara St., for furnishing and erecting complete power plant, conduit system and sewer system. Sellon & Hemmings, State Architects, 244 Kearney St., San Francisco.

Jefferson Barracks, Mo.—Electric Lighting System.—Until 11 a. m., Dec. 22, by Capt. O. W. Bell, Q. M., for a complete electric lighting system, consisting of the following items: Wiring buildings, constructing pole lines, furnishing electric fixtures, transformers and apparatus. Bids to furnish electric current for lighting will also be received.

Clinton, N. C.—Dam.—Until Dec. 7, by A. J. Johnson, Chairman County Commissioners, for constructing dam across Little Coharie. Dam is to be about 1,500 ft. long and about 3½ ft. high.

New York, N. Y.—Metal Storage Cabinets.—Until 3 p. m., Dec. 3, by the Park Board, Arsenal Bldg., Central Park, for the construction of 40 metal storage cabinets for laboratories, Museum of Natural History.

Memphis, Tenn.—Street Lighting.—Until noon, Dec. 10, by Ennis M. Douglass, City Register, for furnishing the city gas and gasoline lights for the year 1909 on an all-night and every night schedule.

Cheyenne, Wyo.—Concrete Dam.—Until Nov. 30, by City Clerk, for constructing dam to contain 7,500 cu. yds. concrete, 3,847 cu. yds. earth fill and 348 cu. yds. rip rap. Work also includes removal of 1,643 cu. yds. solid rock and 547 cu. yds. loose rock.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Boilers, Generators, Rope, Etc.—Until 10:30 a. m., Dec. 14, by Capt. F. C. Boggs, General Purchasing Agent Isthmian Canal Commission, for furnishing, under Circular 481, boilers, with stack, breeching, uptakes and fittings, surface condenser, generator and engine, brake-rod connection pins, brake-shoe keys, truck-holster center plates, coupler knuckle pins, steel tubing, gaskets, mortising chisels, ma-

chine bits and bitstocks, hemp rope, plate glass, etc.

Washington, D. C.—Flooring Timber.—Until 2 p. m., Nov. 30, by Bernard R. Green, Superintendent of Construction, for furnishing and delivering Georgia pine dressed flooring timber required for the new building for the National Museum in this city.

Chicago, Ill.—Lumber.—Until noon, Dec. 1, by Repair Department of the Board of Education, Room 709 Tribune Bldg., for sundry items of lumber to be delivered to the workshops of the board, 161 W. Monroe St., Chicago.

Fort Leavenworth, Kan.—Ballast.—Until 11 a. m., Dec. 7, by Capt. Win. D. Davis, Constructing Q. M., for furnishing and delivering in good condition f. o. b. cars, freight prepaid, 1,200 cu. yds. ballast for U. S. railway terminals at Fort Leavenworth.

National Military Home, Kan.—Dry Cleaning Plant.—Until noon, Nov. 30, by Major W. W. Martin, Treasurer, Western Branch, N. H. D. V. S., National Military Home, for furnishing and installing machinery and all equipment for a complete dry cleaning plant.

New Orleans, La.—Fire Hose.—Until Dec. 1, by J. W. Lewis, Commissioner, for furnishing 1,200 ft. of multiple woven seamless fire hose.

Grand Rapids, Mich.—Water Meters.—Until Dec. 3 by Board Public Works, S. A. Freshney, Secretary, for furnishing 847 water meters.

Duluth, Minn.—Fire Hose.—Until noon, Nov. 27, by Fire Commissioners, Harry H. Lemont, Secretary, for furnishing 4,000 ft. 2½-in. fire hose.

New York, N. Y.—Curbstones.—Until 3 p. m., Dec. 3, by Park Board, Arsenal Bldg., Central Park, for furnishing and delivering new straight 5-in. bluestone curbstones along Broadway where required, between 65th and 80th Sts., in the Borough of Manhattan.

Greenville, Tex.—Pipe, Specials, Valves.—Until noon, Dec. 1, by Mayor Jos. F. Nichols, for furnishing and delivery, free on board cars at Greenville, of the following cast-iron pipe, valves and specials: 500 ft. standard 16-in. cast-iron pipe, 27,300 ft. standard 6-in. cast-iron pipe, 2,700 ft. standard 8-in. cast-iron pipe, 65 2-way hydrants, 2½ ft. bury, 4 8-in. gate valves, 21 6-in. gate valves, 25 extension gate boxes, 20 tons specials. J. W. Maxey Co., Engineers, Binz Bldg., Houston, Tex.

Norfolk, Va.—Portland Cement.—Until Dec. 1, by Bureau Supplies and Accounts, Navy Department, Washington, D. C., for furnishing, under Schedule 591, 1,800 bbis. Portland cement at U. S. Navy Yards, Norfolk.

Norfolk, Va.—Valves.—Until Dec. 1, by Bureau Supplies and Accounts, Navy Department, Washington, D. C., for furnishing, under Schedule 597, miscellaneous valves for U. S. Navy Yard at Norfolk.

Milwaukee, Wis.—Garbage Boxes.—Until 10:30 a. m., Nov. 28, by Board Public Works, Charles J. Poetsch, Chairman, for furnishing for the use of the Health Department, 20 steel garbage boxes and 40 bottoms for garbage boxes.

CONTRACTS LET.

The following contracts have been let recently:

Gadsden, Ala.—Water Works Improvement.—Corinth Engine & Boiler Works, Corinth, Miss., for water works improvements here.

Oakland, Cal.—Depots.—Thomas Day & Sons, for erecting three passenger stations for Western Pacific R. R.—one to be erected at Hayward, one at Livermore and one at San Leandro. Stations will be of mission type and will cost about \$10,000 each. They will consist of concrete below and wire lath and plaster above.

Selma, Cal.—Sewer System.—W. F. Hanrahan, Palo Alto, Cal., at \$33,336, for constructing sewer system for this city.

Greeley, Colo.—Irrigation System.—Parker-Washington Construction Co., St. Louis, Mo., for constructing Henrylyn irrigation system, the work including about 90 miles of ditch and several reservoirs.

Augusta, Ga.—Concrete Dam.—Ambursen Hydraulic Construction Co., 176 Federal St., Boston, Mass., for constructing reinforced concrete dam across the Savannah River at Price's Island, about 25 miles above this city, for the Twin City Power Co. The company will erect two dams across the Savannah River, of which the one at Price's Island will be the first. It will be 30 ft. high and of sufficient thickness to permit of a roadway suitable for cars and wagons to cross it, serving also as a bridge across the Savannah. It will cost approximately \$3,500,000, and will develop 15,000 HP.

Douglas, Ga.—Railroad Work.—A & A. C. Wright Co., for building 20-mile extension of

the Georgia & Florida Ry. American Car & Foundry Co. has contract for erecting bridge over Altamaha River on the extension.

Council Bluffs, Ia.—Fire Station. G. F. Hughes, for erecting central fire station for city.

Council Bluffs, Ia.—Bridge Work.—W. M. Lann, Harlan, Ia., at \$5.5 per lin. ft., for county bridge construction during 1909.

Des Moines, Ia.—Building Work.—James Maine & Sons, for remodeling and rebuilding the Frankel block at 7th and Locust Sts. It will be raised three stories and modernized throughout.

Davenport, Ia.—Sewer.—Independent Construction Co., at 70¢ cts. per lin. ft., for constructing sewer in 15th St.

Aurora, Ill.—Bridge.—William Petersohn & Co., for erecting concrete bridge over Turkey Creek at Spruce St.

Aurora, Ill.—Grading.—George M. Kepner, Cleveland, O., for grading for extension of Chicago, Wheaton & Western Ry. from West Chicago.

Chicago, Ill.—Inspection Work.—Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill., have been awarded by the Chicago & Northwestern R. R. Co. the inspection of the structural materials entering into their new terminal station, of which steel will amount to about 21,000 tons. The same firm have been given the inspection of the steel to be used in the new Blackstone Hotel now being erected at the corner of Michigan Ave. and Hubbard Ct.

Moline, Ill.—Church.—C. C. North, for erecting church building for First Christian Congregation, Rev. R. E. Henry, Pastor.

Springfield, Ill.—Sewers.—Richard Egan, for laying 18-in. sewer in Mason St. and 12-in. sewer in Edwards St.

Greensburg, Ind.—Depot.—Isgrigg & Son, at \$16,000, for building depot here.

Hammond, Ind.—Sewer.—O'Shea & Shea, Hammond, at \$1.35 per lin. ft., for constructing Pine St. sewer.

Logansport, Ind.—Steam Fittings.—Messinger & Sullivan, at \$2,049, for piping and steam fitting for alterations to city electric light plant.

Mt. Vernon, Ind.—Lock and Dam.—Vincennes Bridge Co., Vincennes, Ind., at about \$5,000, for constructing lock and dam for the Hovey Lake Association. Structure will be 35 ft. long and 22 ft. high, and will be built of reinforced concrete.

Mt. Vernon, Ind.—Bridges.—Vincennes Bridge Co., Vincennes, Ind., for following bridges for county: Nolte bridge, \$1,470; Tenberge bridge, \$419; Blairsville bridge, \$229; Knowles bridge, \$425.

Princeton, Ind.—Bridge.—Indiana Bridge Co., Muncie, Ind., for erecting new bridge over Patoka River for county.

St. Marys, Kan.—Water Works, Electric Light Plant.—W. W. Cook & Son, Junction City, Kan., at \$29,200, for constructing water works and electric light plant for this place.

Winfield, Kan.—Building.—Eilenberger Construction Co., Chicago, Ill., for the new administration building of Southwest Kansas College.

Natchitoches, La.—Bridge.—George Graham, at \$1,150, for erecting 540-ft. bridge over Bayou Pierre.

Boston, Mass.—School House.—C. H. Belledon, at \$81,000, for constructing school house on Moore St., East Boston.

Chelsea, Mass.—School Building.—Whiton & Haynes, John Hancock Bldg., Boston, Mass., for construction of Williams School to cost about \$160,000, and to be of fireproof construction of red brick with light terra cotta trimmings.

Fitchburg, Mass.—Building.—S. S. & H. N. Lawrence, Fitchburg, for new industrial arts building to be erected on grounds of Normal School in this city.

Grand Rapids, Mich.—Pumping Station.—J. P. Rusche, at \$9,300, for erecting brick sewer pumping station.

Menominee, Mich.—Power Plant Equipment.—Contracts for machinery and electric apparatus for the Northern Hydro Co.'s power plant at Grand Rapids have been let as follows: Dayton Globe Iron Works, Dayton, O., to furnish water turbines sufficiently strong to generate 4,250 H.P. They will also furnish four automatic Lombard governors. The Westinghouse Electric Manufacturing Co. was given the contract to supply the generators, dynamos and switchboards.

Mankato, Minn.—Grading.—H. F. Balch, at about \$100,000, for grading near Savage for the Ivan Patch Electric Line.

St. Joseph, Mo.—Sewers.—Contracts for district sewers have been let as follows: In District No. 64, G. O. Skillbred; District No. 57, awarded to G. O. Skillbred; in District

No. 18, awarded to E. S. Mignery, in District No. 115, awarded to J. H. Hartman; in District No. 59, awarded to James Marnell.

Fargo, N. Dak.—Sewers.—James Kennedy, for constructing sewer in 11th St. and a sewer in 7th Ave.; C. H. Porritt, for sewer in 8th Ave.; G. W. Haggart, for sewer in 12th St.

Salem, N. H.—Macadam Road.—Edward Adams, North Andover, Mass., for constructing 4,000 ft. of macadam road here.

Elizabeth, N. J.—Sewer.—McCloud & Co., Elizabeth, at \$173,965, for constructing intercepting sewer for city. Work includes 2,560' 41" to 13' deep; 1,140' 42" to 11'; 350' 10" to 16'; 1,000' 35" to 12'; 167' 1,200' 35" to 16'; 700' 35" to 16'; 500' 36" to 16'; 245' 2,150' 32" to 15' to 25'; 1,200' 30" to 25'; 250' 30" to 17' to 24'; 250' 28" to 17' to 20'; 200' 28" to 24'.

Albany, N. Y.—Road Work.—Additional contracts for state road work, bids for which were opened Nov. 9, 11 and 13, by Frederick W. Skene, State Engineer and Surveyor have been let as follows: Road No. 564, 5.02 miles, Brown & Lowe, Schenectady, N. Y., \$47,149 (for syenite); Road No. 585, 3.33 miles, H. V. Sprout, Peekskill, N. Y., \$36,841; Road No. 612, 2.92 miles, Joseph Walker, New Paltz, N. Y., \$29,323; Road No. 627, 8.1 miles, J. E. Consauls, Saugerties, N. Y., \$56,474; Road No. 635, 5.04 miles, Monroe Roads Co., Pittsford, N. Y., \$37,919; Road No. 636, 3.16 miles, Hulihan & Daley, Rochester, N. Y., \$20,563; Road No. 642, 6.9 miles, Joseph Dunfee, Syracuse, N. Y., \$84,582; Road No. 644, .73 miles, F. W. Knickerburg, Buffalo, N. Y., \$8,417; Road No. 645, 4.64 miles, Booth & Flinn, Pittsburg, Pa., \$56,134; Road No. 646, 4.12 miles, Joseph Walker, New Paltz, N. Y., \$32,852; Road No. 654, 5.35 miles, Central & Eastern Construction Co., Albany, N. Y., \$54,042; Road No. 663, 4.42 miles, John H. Gordon, Albany, N. Y., \$48,234 (for limestone); Road No. 681, 5.23 miles, P. D. Conley, Ithaca, N. Y., \$57,333; Road No. 685, 5.23 miles, Stewart-Kerbaugh-Shanley Co., 527 Fifth Ave., New York, \$57,423; Road No. 690, 4.25 miles, J. E. Consauls, Saugerties, N. Y., \$28,480; Road No. 708, 4.68 miles, John Harrigan, New York City, \$35,541; Road No. 713, 5.13 miles, Bellev & Merritt Co., Tuckahoe, N. Y., \$38,706; Road No. 714, 5.37 miles, Greece Construction Co., Rochester, N. Y., \$56,945; Road No. 723, 4.72 miles, Putnam & Hare, New York City, \$31,609; Road No. 725, .9 miles, Casey & Murray, Rochester, N. Y., \$14,112; Road No. 734, 5.15 miles, Spuyten Duyvil Construction Co., New York City, \$36,324; Road No. 736, 4.12 miles, Shanley-Morrissey Co., New York City, \$28,105; Road No. 737, 5.79 miles, Chambers & Grady, Rochester, N. Y., \$47,878; Road No. 747, 5.91 miles, John Harrigan, New York City, \$55,635; Road No. 750, 5.95 miles, Joseph Dunfee, Syracuse, N. Y., \$59,003; Road No. 754, 1.46 miles, Stewart-Kerbaugh-Shanley Co., 527 Fifth Ave., New York City, \$12,567; Road No. 784, 3.12 miles, Malloy & Davis, Schenectady, N. Y., \$31,431; Road No. 788, 7.32 miles, Malloy & Davis, Schenectady, N. Y., \$64,227; Road No. 794, 10.14 miles, Henry J. Mullen, Jamaica, N. Y., \$87,876; Road No. 795, 6.2 miles, Bellev & Merritt, Tuckahoe, N. Y., \$49,903; Road No. 796, 4.62 miles, Thomas O'Hern, Yonkers, N. Y., \$36,825.

Albany, N. Y.—Barge Canal Work.—Contracts for work on New York State barge canal, bids for which were opened Nov. 17 and 18, have been let as follows: Contract 19, improvement of Erie canal from Lockport to Sulphur Springs guard lock, to the United Engineering & Contracting Co., New York, for \$2,166,298. Contract 41, east of Rochester, to Butler Bros.-Hoff Co., New York, for \$281,330. Contract 46, from Fox Ridge, Cayuga County, to Salem, Wayne County, to the Kinser Construction Co., of Fort Edward, N. Y., for \$1,212,833. Contract 47, in Cayuga County, to the Crowell & Sherman Co., of Cleveland, O., for \$1,262,638. Contract 68, construction of dams and locks in the upper Hudson, to Shanley-Morrissey, Inc., of New York, for \$1,018,323.

Brooklyn, N. Y.—Paving.—John O'Grady, Brooklyn, at \$4.25 per cu. yd., for concrete foundation and \$2.35 per sq. yd. for granite pavement on Grand St.; contract amounts to about \$25,000.

Cincinnati, O.—Road Work.—County Commissioners have awarded following contracts: Repair of Lee's Creek Road, Harrison and Crosby Townships, Nugent & Hines, \$4,539; improvement of Rapid Run Road, Delhi Township, John Funke, \$2,494; repair of Wiebe Road, Columbia Township, John Snyder, \$2,111; repair North Bend Road, Springfield Township, W. P. Flynn, \$1,127.

Galion, O.—Sewer.—H. J. Glover, Lorain, O., at about \$22,000, for constructing trunk sewer.

Springfield, O.—Sewer.—Gould & Wright, Toledo, O., at \$10,461 and \$6,170, for constructing two sewers here.

Steubenville, O.—Warehouse.—James

Coyne, at \$17,000, for erecting brick and iron warehouse for Mozelle-Johnson Co.

Toledo, O.—Filter Plant Work.—A Bentley & Sons Co., Toledo, at \$11,358, for work at city filter plant.

Anadarko, Okla.—Power Plant, Etc.—O'Neill Engineering Co., Dallas, Tex., for improvements to cost about \$85,000, and to include constructing dam, extending light, water and sewer systems.

Youngstown, O.—Paving.—Kennedy Bros., at \$18,859, for paving 11th St.

Bartlesville, Okla.—Bridge.—E. A. Hanna, at \$2,654, for constructing iron bridge on concrete abutments over Turkey Creek for county.

Oklahoma City, Okla.—Paving Work.—Contracts aggregating \$813,789 for street improvement work for this city have been let as follows: Asphalt pavement, Onway Paving Co., 138 Washington St., Chicago, Ill., \$217,159; Parker-Washington Co., 4500 Duncan Ave., St. Louis, Mo., \$118,820, and Cleveland-Trinidad Paving Co., Cleveland, Ohio, \$27,099; for alley brick pavement, Joseph A. Hanna Co., of Oklahoma City, about \$1,800; for grading streets and alleys a distance of about 14 miles, Bennett & Acklin Co., and J. R. Alley Co., at \$50,000. Total cost, \$813,879. W. C. Burke is City Engineer.

Shawnee, Okla.—Paving Work.—This city, F. D. Brown, City Engineer, on Oct. 31, let contract for brick and asphalt pavement work at following bids: Asphalt amounting to 37,790 sq. yds., at \$2.17 per sq. yd.; brick amounting to 20,788 sq. yds., at \$1.91 per sq. yd.; curb and gutter amounting to 27,000 lin. ft. at 70 cts. per lin. ft.; marginal curb, 15,000 lin. ft., at 25 cts. per lin. ft.; intake basins, 67 at \$2.27 per vertical ft.; castings amounting to 40,000 lbs. at 4 cts. per lb.; manholes, 23 at \$1.00 per vertical ft. This and the contract awarded June 20 make an aggregate of about 11 miles of paving. In addition to the above, contracts will shortly be let for about eight miles more of paving, all asphalt, making a total of about 19 miles.

Erie, Pa.—Dock.—McClintic-Marshall Co., Pittsburg, Pa., at \$12,290, for constructing dock here.

Monongahela, Pa.—Electric Railway.—Piehl & Miller, Wabash Bldg., Pittsburg, Pa., for constructing 14 miles of electric railway for the Monongahela & Carroll Street Ry. Co.

New Cumberland, Pa.—Sewers.—N. F. Reed, for constructing sewers for this place.

Lemmon, S. Dak.—Water Works Plant.—J. A. Hunt, for the concrete work and the superstructure for the water works plant.

Rogersville, Tenn.—Pike Roads.—Patten, Turner & Co., for constructing pike roads for Hawkins County.

Austin, Tex.—Bridge.—William P. Carmichael Construction Co., St. Louis, Mo., at \$176,490, for construction of a bridge across the Colorado River at Columbus Ave. The structure will be 942 ft. long, 48 ft. wide and will be built of steel and reinforced concrete.

El Paso, Tex.—Bridges.—El Paso Bridge & Iron Co., for constructing two steel bridges in the upper valley for county.

Houston, Tex.—Pump.—Nordberg Co., at \$47,500, for furnishing city with 15,000,000-gallon pump.

Temple, Tex.—Pumping Station.—H. D. McCoy, Cleburne, Tex., for building a new brick pumping station for the city water works system.

Clarkson, Utah.—Water Works.—Wheelwright Construction Co., 2476 Washington Ave., Ogden, Utah, for constructing water works for this town. System will consist of about 9½ miles of pipe line; concrete reservoirs are also to be built. Pipe for the system will be furnished by the Ogden Sewer Pipe & Clay Co., Ogden.

North Yakima, Wash.—Bridge.—Burrell Bridge & Construction Co., Seattle, Wash., at following bid for constructing bridge over Yakima River at Parker: Concrete piers, \$1,150, or \$12.95 per cu. yd.; 210-ft. span, \$2,398; 48-ft. span, \$200; steel floor beams, \$80 each.

Spokane, Wash.—Railway Grading.—Cochrane & Woodson, for grading 12 miles of right of way of North Coast Ry. Co., west of Kennewick; Case & Esback received contract for grading eight additional miles.

De Pere, Wis.—Sewer.—Thomas Conley, at \$1.10 per lin. ft., for constructing 900 ft. of 30-in. pipe sewer.

Mullins, W. Va.—Railroad Work.—Virginia Ry. has let contracts amounting to about \$1,000,000 for constructing a branch from Mullins to Pemberton. The contractors are as follows: Carpenter & Boxley, 15 miles; Mason, Hanger & Co., five miles; Towles & Boxley, two miles; J. S. Lipscomb, three miles.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States

Batesville, Ark.—County Commissioners are to erect six steel bridges. A. M. Lund, Little Rock, Ark., is Engineer.

Los Angeles, Cal.—Residents of South Pasadena are asking that \$50,000 bridge be built over the Arroyo Seco at Lincoln Park.

Marshalltown, Ia.—City and county are to jointly erect bridge at 13th St. to cost \$3,000.

Cedar Rapids, Ia.—City Council is taking steps to secure construction of a bridge at 3rd Ave.

Des Moines, Ia.—Surveys have been made for bridge to be erected by U. S. War Department over North River to Fort Des Moines.

Sioux City, Ia.—Plans of City Engineer Skeels for viaduct on Wall St., between 4th and Grand Sts., have been submitted to State Board of Railroad Commissioners.

Peoria, Ill.—Peoria & Pekin Union Ry., Stanley Millard, Chief Engineer, Peoria, has approved plans for a new steel double track bridge to be erected over the Illinois River and construction work is to be started in the spring. The bridge will cost about \$525,000.

Leavenworth, Kan.—At recent election it was voted to build three concrete bridges.

Lawrence, Mass.—State Railroad Commissioners gave public hearing No. 23 on the plans of Prof. G. F. Swain, Massachusetts Institute of Technology, Boston, for the proposed bridge over the Merrimack at this city.

Cumberland, Md.—Pennsylvania & Maryland Electric Ry. will erect an iron bridge over the Casselman River at Garrett Park. It will have a 140-ft. span.

Takoma Park, Md. (P. O. Washington, D. C.)—Following bids were received Nov. 11 by Town Clerk for constructing reinforced concrete bridge over Sligo Branch: William A. Fry, \$14,185; Washington Sanitarium Association, \$11,944; Lake Stone Co., \$12,778.

Oxford, Me.—John Robinson, owner of the local woolen mills, is stated to have offered to build a bridge over the Little Androscoggin, provided the proposed electric railway connecting Mechanic Falls with Norway and South Paris be built through Oxford.

Grand Rapids, Mich.—L. W. Anderson, City Engineer, has plans under way for a foot-bridge over the Grand Trunk tracks to cost several thousand dollars.

St. Paul, Minn.—City Park Board has recommended that concrete bridge be built at Lexington Ave. over the Great Northern Ry. to replace the present structure at that place.

Cincinnati, O.—City Bridge Engineer Morris has estimated cost of repairing Liberty St. viaduct at \$32,882; this includes bracing and re-enforcing steel columns and concrete work.

Cleveland, O.—R. W. Hoffman, City Engineer, is working on plans for a 1,700-ft. bridge to eliminate Nickel Plate Ry. crossing at W. 25th St. and Walworth Run. The bridge will cost about \$350,000.

Fremont, O.—Lake Shore Electric Ry., F. W. Coen, Superintendent, is having plans made for a new bridge to be erected in this city. Hearing on the matter will be held by County Commissioners on Nov. 30.

Youngstown, O.—Conference is to be held between F. M. Lillie, City Engineer, and engineers of the B. & O., the Erie, and the Pennsylvania R. R., looking to the elimination of the Spring Common grade crossing.

Portland, Ore.—Council has passed ordinance to call a special election to vote on issuing \$2,000,000 of bonds for the construction of a high bridge over the Willamette River, as recommended by Ralph Modjeski, Consulting Engineer, Monadnock Bldg., Chicago, Ill. The proposed bridge is to be of the bascule type with central span 96 ft. above low water.

Philadelphia, Pa.—The Survey Committee of the City Council has passed an ordinance for the construction of a bridge over the Chestnut Hill branch of the Pennsylvania R. R., at Roberts Ave., to cost \$40,000.

Brownsville, Tex.—Plans for the proposed bridge over the Rio Grande at this place are stated to have been practically completed. The bridge will be built for the St. Louis, Brownsville & Mexico R. R., of which J. N. Miller, Kingsville, Tex., is General Manager.

Fort Worth, Tex.—City and County is to be asked to construct a second bridge over the Trinity River to connect the city with North Fort Worth.

Bowling Green, Va.—County Supervisors have approved plans of Roanoke Bridge Co., Roanoke, Va., for a steel bridge to be erected over the North Anna River.

Railroads.

Items Arranged Alphabetically by States.

Birmingham, Ala.—Local press reports state that the Southern Ry. will soon begin double tracking its line between this city and Washington City. W. H. Wells, Washington, D. C., is Engineer of Construction, Southern Ry.

Denver, Colo.—Announcement has been made that \$10,000,000 of the new bond issue of the Denver & Rio Grande R. R., has been underwritten and that the money will be used to complete the Western Pacific Ry. The latter is virtually an extension of the D. & R. G., being constructed from Salt Lake City to San Francisco. V. G. Rogue, Mills Bldg., San Francisco, Cal., is Chief Engineer.

Denver, Colo.—Colorado & Southern Ry., H. W. Cowan, Chief Engineer, Denver, is stated to be about to purchase 15,000 to 18,000 tons of rails for new works. The principal improvement which will probably be made is the building of a new line between Pueblo and Walsenburg. The extension of the Fort Collins branch to Cheyenne will also probably be carried out in a short while.

San Diego, Cal.—Local Harbor Commissioners are to have surveys made to establish high tide line all the way around the bay. The State Harbor Commissioners, Sacramento, also propose to construct a 36-mile belt line around the bay, the railroad to be owned by the State.

Douglas, Ga.—Georgia & Florida Ry. has let contracts for the construction of 30 miles of road, and a steel bridge over the Altamaha River. G. B. Hazelhurst, Douglas, Ga., is Chief Engineer.

Americus, Ga.—Local Board of Trade is formulating plans for building a branch line 20 miles long from Vienna to a connection with the Atlanta, Birmingham & Atlanta R. R. W. A. Kennon, Division Engineer, Fitzgerald, Ga.

Pocatello, Idaho.—Directors of Minidoka & Southwestern R. R. have recommended the extension of the present line to Wells, Nev. The road is controlled by the Oregon Short Line R. R., of which J. P. Congdon, Pocatello, is Supervising Engineer.

Boise, Idaho.—Local press reports state that the Idaho Railway & Navigation Co. has secured necessary capital and greater part of its right of way for the immediate construction of its new branch line to tap southeastern Washington and eastern Oregon.

Weiser, Idaho.—Pacific & Idaho Northern Ry., R. E. Merrick, Chief Engineer, Weiser, Idaho, is to take up matter of constructing its proposed extension from Evergreen to Meadows Valley and from there the construction of a branch line in Long Valley.

Pana, Ill.—Cleveland, Chicago, Cincinnati & St. Louis Ry., W. M. Duane, Chief Engineer, Cincinnati, O., is contemplating double tracking its line between this city and Terre Haute. The road has double track from Pana to St. Louis and double track from Terre Haute to Indianapolis and the connection between the two points means better transportation facilities for all lines. The connection will mean double track from St. Louis to Indianapolis.

Garden City, Kan.—Construction work on the Nebraska, Kansas & Southern R. R., is to be started here this month, according to a statement of A. F. McCarty, promoter of the company. The construction company will build the first mile of grade out of town, and then, from there on, sub-contractors will be given the work. Baxter Brown, St. Louis, Mo., is the Engineer.

Paducah, Ky.—Mass meetings of citizens of Paducah, Wickliffe, Barlow, La Center and Maxon Mills have been held to raise bonuses for the construction of the Kentucky & Ohio River R. R., from this city to Wickliffe.

Monroe, La.—Advices from this city state that the Louisiana, Arkansas & Gulf Ry. will shortly build an extension from Ham-burg to Pine Bluff, Ark., about 60 miles. E. T. Bond is Chief Engineer at Bastrop, La.

Springfield, Mass.—Boston & Albany R. R., I. F. Deems, General Superintendent Motive Power, New York, has secured site in West Springfield, on which to erect a 70-ft. tall round house.

Hibbing, Minn.—It is reported here that the Great Northern Ry., A. H. Hogeland, Chief Engineer, St. Paul, Minn., will shortly let a contract for the extension of its line from Nashauk to Grand Rapids. At present the Great Northern Ry. runs a branch line from Hibbing to Nashauk, a distance of 14 miles. The extension from Nashauk to Grand Rapids would require about 20 miles of railway construction.

Marceline, Mo.—Atchison, Topeka & Santa Fe Ry. will probably resume the building

of its second track (short line) through Missouri early next year. This work was suspended some time ago. The second grade is practically completed from Fort Madison to Wyaconda. Some work has also been done between Wyaconda and Marceline. Under favorable conditions it is expected the entire work through Missouri will be completed next year.

Dickinson, N. Dak.—Committee of local Commercial Club, Mayor Geo. M. Frye, Chairman, has been appointed to secure funds for making a preliminary survey for a railway from Dickinson to Lemmon.

New York, N. Y.—It is reported here that the Delaware, Lackawanna & Western Ry. is planning to buy a connecting line which will give it an entrance to Chicago, Ill. The report states that the \$25,000,000 worth of improvements now under way on different parts of the system, together with other improvements to be commenced next year, will be followed by the extension of the Lackawanna lines to Chicago.

Clinton, Okla.—Clinton & Oklahoma Western Ry., with \$500,000 capital stock and headquarters at Clinton, has been chartered and proposes to build a steam road from Clinton northwest to Guymon and south-east to Lehigh, a distance of 400 miles. The estimated cost of the road is \$10,000 per mile. The incorporators are T. J. Nance, E. A. Humphrey and J. T. Bradford, of Clinton, and C. C. Goodman, of Fort Smith, Ark. The Orient system is reported to be backing the project.

Lawton, Okla.—Plans are reported under way for new construction work on the Lawton, Wichita Falls & Northwestern Ry. Charles Oth, Engineer, Radlett, Okla. Work on the road is now under way and part of the line from Wichita Falls to Frederick, Okla., is in operation.

Chambersburg, Pa.—Cumberland Valley R. R., T. J. Erereton, Engineer, Chambersburg, will shortly commence the construction of an overhead freight line through this place to cost \$1,000,000.

Abilene, Tex.—Abilene & Ballinger R. R. has let contracts for grading from Abilene to Winters, Tex.

El Paso, Tex.—San Diego, El Paso & St. Louis R. R. Co. has been incorporated with a capital stock of \$100,000, and proposes to build a line about 100 miles long northeast from El Paso. The incorporators are A. Courchesne, James A. Dick, W. C. Davis, Horace B. Stevens, Z. T. White, L. E. Booker, J. J. Mundy, W. Cooley, J. A. Smith, John A. Happer, W. J. Harris and Irvin John, all of El Paso, Tex.

Richmond, Va.—Richmond, Urbanna & Peninsular Ry. Co., 1113 East Main St., has voted an issue of \$300,000 in stock and \$500,000 in bonds. The company proposed to build a gasoline motor line from West Point to Urbanna on the Rappahannock River, through the counties of King William, King and Queen, Gloucester and Middlesex.

Everett, Wash.—Advices from this city state that the Great Northern Ry., A. J. Hogeland, Chief Engineer, St. Paul, Minn., has plans in course of preparation for the construction of a tunnel 12 miles long to pierce the Cascade Mountains at a point some distance east of the entrance of the existing bore and to emerge on this side near the town of Scenic. The work is planned to reduce grade and to eliminate the roundabout course now followed by the road.

Electric Railways.

Items Arranged Alphabetically by States.

Phoenix, Ariz.—Local press reports state that a company known as the Mercantile Transportation & Smelting Co., of Chicago, Ill., is to construct an electric railway from Maricopa to the Gulf of California. Negotiations are stated to be under way to secure a concession for the line from the Mexican Government.

Berkeley, Cal.—Southern Pacific Co. has applied to Town Trustees for franchises to extend three through town electric lines. The company is said to be planning to expend \$2,000,000 for new lines and changes in the city.

Corte Madera, Cal.—Citizens of Western San Rafael, San Anselmo, Ross and Kantfield may organize a stock company to build a street car line between the towns.

Los Angeles, Cal.—Los Angeles & Mt. Washington Ry. Co. has been chartered with a capital stock of \$150,000. Robert Marsh, J. E. Marsh, A. St. C. Perry, Henry J. Stevens and John Howze are the incorporators.

Modesto, Cal.—Preliminary steps have been taken for building an interurban line between Stockton and Modesto by way of French Camp, Atlanta and Escalon. A

branch line connecting with Riverbank or Oakdale is also proposed. Surveys are to be made at once and right of way secured. W. H. Killiam, Secretary Chamber of Commerce, Modesto, is interested.

Padadena, Cal.—The Pasadena Rapid Transit Co. is being organized here for the purpose of building an electric railway between Pasadena and Los Angeles. It is proposed to utilize the old Pasadena-Los Angeles Cycleway and right of way to the new road. The company is to be capitalized at \$3,000,000. Horace M. Dobbins is President.

San Francisco, Cal.—Reports from this city state that a company has been organized here with \$12,000,000 capital stock for the purpose of constructing an electric railway from San Francisco through Sacramento to Lake Tahoe. The project is reported as being promoted by W. B. Porterfield, President of the U. S. Trust Co., Los Angeles, Cal.

Stockton, Cal.—Stockton Terminal & Eastern R. R. has been incorporated with a capital stock of \$600,000, and proposes to build a road from Stockton to Jenny Lind. The total length will be about 30 miles. The directors of the company are: A. Shane, Indianapolis; W. H. Newell, Stockton; A. A. Grant, Sonoma; M. J. Condon, Berkeley; E. F. Davis, S. L. Steidley, Oakland; J. E. Adams, Berkeley; Robert F. Burns, Berkeley; R. V. Dixon, Oakland.

San Pedro, Cal.—E. D. Seward and William Peck have asked franchise for a street railway line to connect with the Point Firmin system at 15th St., and thence to the north side of the city.

Golden, Colo.—Lookout Mountain Ry. Co. has applied to city council for franchise on certain streets. According to plans, the proposed railway will connect with the Denver & Northwestern and run to the city limits. Then, by a series of switches and loops, the new line will climb to the summit of Lookout Mountain, four miles west of Golden, and 1,700 ft. higher.

Atlanta, Ga.—Atlanta Northwestern Electric Ry. Co. has been granted permission to issue \$1,200,000 of stocks and bonds for the purpose of constructing a line from Atlanta to Cumming, 42 miles. The plans contemplate a line from Atlanta to Cumming, through Roswell and Alpharetta. Several extensions are also contemplated.

Atlanta, Ga.—Construction of an electric railway to connect with local lines at College Park, and give service from Union City and Fairburn is proposed by W. T. Roberts, Fairburn; J. H. Harris, Union City, and J. C. Longino, Fairburn.

Clinton, Ia.—Clinton Street Ry. Co. has been securing material for a 4,000-ft. extension of its tracks here.

Alton, Ill.—Alton, Jacksonville & Peoria Ry. Co. has increased its capital stock from \$600,000 to \$2,000,000 and will, it is said, soon resume construction work on its line from Godfrey to Jerseyville, and from the latter place to Jacksonville. The road has been completed from Alton to Godfrey, seven miles.

Oregon, Ill.—Surveys for the proposed electric railway from Oregon to Paynes Point have been completed by J. B. Bertoleto, County Surveyor. Partial survey from Paynes Point to Stillman Valley has also been made.

Chicago, Ill.—Chicago Railways Co., 181 La Salle St., has completed plans for a new tunnel in La Salle St., and will proceed with the work as soon as plans are approved by city. The tunnel will be lined with concrete and will cost about \$1,000,000.

Kokomo, Ind.—Survey has been completed and maps, profile, etc., are being prepared for an interurban line which the Kokomo Western Traction Co. proposes to build from Kokomo, Ind., to Burlington, Ind., a distance of 15½ miles. The line will open up a large territory of as rich and highly improved land now entirely without facilities of any kind. The company will handle all passenger, freight, (local and car load), express, baggage and mail from this territory, and have decided to use independent gasoline motor cars for passenger, baggage, express and mail, and gasoline locomotive for local and car load freight. C. C. McFann of Kokomo, Ind., President and General Manager, states that he is now taking up the financing of the proposition and investigating the different equipment and material adapted to his work, regarding which information and quotations will be appreciated.

Lawrence, Kan.—Advices from this place state that actual work on the proposed electric line connecting Kansas City and Topeka, via Lawrence and also to Independ-

ence by way of Lawrence, will begin within 60 days.

Billings, Mont.—Preliminary surveys have been made for the proposed electric railway from this city to Laurel, and construction work will be started shortly, it is said. N. S. Poole and M. E. Estep are interested.

Goldfield, Nev.—County Commissioners have granted a franchise for a street railway in this city, Columbia and Diamond fields, one mile from the line.

Portland, Ore.—Oregon Electric Co., Guy W. Talbot, General Manager, may expend \$600,000 the coming year for new equipment and extensions. Part of this money will go for building the line from Tigardville to McMinnville.

El Paso, Tex.—El Paso & Fort Hancock R. R. Co. has been organized with a capital stock of \$100,000, and proposes to build an electric railway between El Paso and Fort Hancock. Charles N. Bassett, is President.

Spottsylvania, Va.—Company may be organized here to build an electric railway line to run from Fredericksburg to Spottsylvania and on to Mineral City, in Louisa County.

Vancouver, Wash.—Vancouver Traction Co. will soon commence construction work on an extension of its electric line from Vancouver, 20 miles north of La Center, at the head of navigation on the Lewis River. The line is to be a part of a 100-mile interurban system that is being planned for Clark County. The company is controlled by the Willamette Valley Co., A. Welch, Manager, Fenton Bldg., Portland, Ore.

Morrisburg, Ont.—J. W. Alliso, Morrisburg, is reported to be promoting project for building an electric railway from this place to a connection with the Ottawa & New York Ry.

Windsor, Ont.—Windsor Tunnel & Lake Erie Electric Ry. Co. is seeking franchise here.

Sewers.

Items Arranged Alphabetically by States.

Colfax, Cal.—City has secured water supply and will now take steps to install a sewer system.

San Diego, Cal.—Work is to be started shortly on sewer and water extensions to cost \$65,000.

Seima, Cal.—City received 24 bids Nov. 2, for constructing its sewer system. All but the following were rejected, and these were held for final consideration: Stanley Contracting Co., San Francisco, \$34,203; Davis & Heuser, Salt Lake, \$34,056; Heefy & Murphy, Oakland, \$33,892; W. F. Harrahan, San Francisco, \$33,336. W. H. Shafer, City Engineer.

Willows, Cal.—Town has voted to issue \$30,000 of bonds for a sewer system.

Athens, Ga.—City has decided to construct several new sewers, which, according to report of City Engineer Barnett, will cost \$6,471.

Clinton, Ia.—City council is considering constructing sewer in District No. 4. Wm. E. Hayes, City Clerk.

Alton, Ill.—Board Local Improvements has taken up matter of constructing State St. sewer.

Chicago, Ill.—Engineering Committee of Trustees of Sanitary District of Chicago, American Trust Bldg., have ordered the erection of an experimental sewage purification plant at 92nd St. and the Calumet River, to cost \$3,000. The plant will have a capacity of 700,000 gallons a day and will be completed and in operation within 90 days.

Farmer City, Ill.—Public hearing was held Nov. 23, preliminary to construction of about one mile of sewer.

Hegewisch (Sta. Chicago), Ill.—Village Board has passed ordinance for installing complete sewer system. Work, however, may not be done until next season.

Mendota, Ill.—Council is considering constructing sewers in Monroe St., west from Indiana Ave.

Fort Wayne, Ind.—Board Public Works is to have storm sewer constructed in Nebraska Ave.

Franklin, Ky.—City has voted to issue \$20,000 of bonds for constructing sewers.

Bowling Green, Ky.—City voted Nov. 3 on issuing bonds for constructing sewer system.

Lexington, Ky.—City has voted to issue \$25,000 of bonds for sewer construction, and work will be started soon.

Kansas City, Mo.—City will issue \$3,000,000 of bonds, of which \$300,000 will be for work for disposition of sewage.

Milford, Mass.—Sewer Commissioners, C. H. Waters, Superintendent, are to extend sewer on West A.

Baltimore, Md.—Sewerage Commission is making out plan for system of sanitary drainage for Forest Park. Plan calls for a temporary disposal plant west of Garrison Ave., to care for the sewage from 1,000 houses.

Jackson, Mich.—City has voted \$40,000 for trunk sewers.

Trenton, Mich.—Village Trustees are considering installing sewer system.

St. Paul, Minn.—City Assembly has passed ordinance providing for issuance of \$75,000 of bonds, for construction of Portland-Aldine sewer system.

Pittsburg, Mo.—City council has passed ordinance for constructing additional sewers.

Springfield, Mo.—Council Sanitary committee plans construction of two new sewers in 7th ward.

Grand Forks, N. Dak.—City Engineer is preparing plans for trunk sewer in De Mers Ave.

Wampsville, N. Y.—George S. Tibbitts, City Engineer, Oneida, N. Y., has completed plans for sewage disposal plant for new County buildings at this place.

Ashtabula, O.—Board Public Service is preparing plans for sewer in West Prospect St.

Marion, O.—City is planning to enlarge its sewage disposal plant. George Dwyer, City Engineer.

Warren, O.—Ordinance is before council for constructing storm water sewers.

Holdenville, Okla.—City Engineer has plans under way for a sewer system.

Millville, N. J.—State Health Board has directed that this place must have its proposed sewage disposal plant in operation by July 1, 1909.

Cambridge Springs, Va.—State Health Department has refused this place permission to construct sewer system until sewage disposal plant was provided.

Clintonville, Pa.—Village must construct sewage disposal plant before installing proposed system, according to a ruling of the State Health Department.

Carbondale, Pa.—City is considering constructing five sewers next spring. B. R. Blair, City Engineer.

Harrisburg, Pa.—Lynch & Hessenberger, at \$1,749.50, was low bidder Nov. 6, for sewer in 15th St.

St. Clair, Pa.—State Health Department has refused approval of plans of this place for a sewer system.

Manning, S. C.—R. E. & E. N. Beaty, Engineers, Georgetown, S. C., are to make surveys and designs for a sewer system for this city.

San Antonio, Tex.—Contracts are to be let shortly for sewer system for the Prospect Hill Improvement District. Bonds for \$45,000 for the work here have been sold.

Winchester, Va.—Election is to be held next month to vote on \$50,000 bond issue for constructing sewers.

Fond du Lac, Wis.—City Engineer has been instructed to prepare specifications for sewer system on west side of river.

Water Supply.

Items Arranged Alphabetically by States.

Bisbee, Ariz.—City has voted to issue \$125,000 of bonds for water works extensions.

Claremont, Cal.—Citizens Light & Water Co. will erect \$6,000 pumping plant and sink new well.

Glendora, Cal.—The Glendora Water Co. has been incorporated with a capital stock of \$75,000. The incorporators include C. C. Warren, B. W. Glidden and F. C. Schiffman.

Pasadena, Cal.—El Molino Terrace Land & Water Co. has been incorporated with a capital stock of \$50,000. The incorporators are: Frank C. Platt, R. J. Bird and I. G. Platt.

San Diego, Cal.—Board Public Works is to begin construction of 24-in. main from 5th and University Ave. to old town reservoir.

East Point, Ga.—City has voted to issue bonds in the sum of \$85,000; \$50,000 to be used for the establishment of a system of water works.

Council Bluffs, Ia.—City has voted \$600,000 of bonds for municipal water works.

Waverly, Ia.—City has voted to issue \$30,000 of bonds for rebuilding the water works.

and electric light plants, recently destroyed by fire. J. C. Ralston is Engineer.

Thornton, Ia.—Citizens' Committee has been appointed to take steps for securing water works.

Darlington, Idaho.—Darlington Water Co. has been incorporated with capital stock of \$4,000.

Spirit Lake, Ia.—City voted \$22,000 bonds for extension of the water works.

Colfax, Ill.—Village Board is considering establishing water works.

Grafton, Ill.—Village Council has passed ordinance for construction of water works.

Hegewisch (P. O., Chicago), Ill.—Water works are to be installed here, work to be started at once.

Baldwin, Kans.—City voted to issue bonds in the sum of \$85,000 for establishing water works.

Wichita, Kan.—City has voted bonds for \$350,000 water works.

Carsonville, Mich.—Town has bonded for \$15,000 for establishing water works.

Chicopee, Mass.—City Council has voted to ask legislative leave to issue \$28,000 of bonds for water works extensions.

Bird Island, Minn.—City Council will extend water mains.

Carl Junction, Mo.—Michel-Cooke Engineering & Construction Co., Joplin, Mo., is to prepare plans for water works for this place.

Kansas City, Mo.—City will issue \$3,000,000 of bonds, half of which will go for water works.

Sutton, Neb.—Local water works station reported to have been destroyed by fire.

Wampsville, N. Y.—County Commissioners are considering water supply for new county buildings here. George S. Tibbits, Oneida, N. Y., is Engineer.

Mansfield, O.—Board Public Service is to extend water mains to plant of National Sheet Metal Co. on Bowman St.

Holdenville, Okla.—City Engineer has been preparing specifications for extending water mains.

Medford, Ore.—City will have work started on the construction of an entire new water system as soon as the source of water supply can be determined, bonds to the amount of \$365,000 having already been voted.

Grant's Pass, Ore.—City will issue bonds for \$94,000 for the Rogue River water plant.

Pittsburg, Pa.—City has voted to issue \$4,430,000 for public improvements. Of this sum \$2,675,000 is for the improvement of the south side water system, and includes \$1,975,000 for purchase of plant, rights, etc., of Monongahela Water Co. The sum of \$300,000 will go for extension of water system to the east end. A. B. Shepherd is Director Public Works.

St. George, Utah.—New water works are to be installed here in the near future.

Haskell, Tex.—Surveys for water and sewer system for this place have been completed.

Hillyard, Wash.—City has voted \$35,000 of bonds for constructing water works.

Renton, Wash.—E. E. Duff, City Councilman, writes us that this city has voted to issue \$23,000 of bonds to build water system. The source of supply is about four miles from the town. Town has a system but has outgrown it so it was necessary to have more water.

Methods and Costs of Constructing a Farm Drainage System.....339
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Reports on the Safety and Sufficiency of the Blackwells Island Bridge, New York City.....344

TILE DRAINS.

Peoria, Illinois.

Sealed bids will be received by the Commissioners of the Hallock & Medina Drainage District of Peoria County, Illinois, at the office of W. S. Kellogg, Attorney, 100 S. Jefferson Ave., Peoria, Illinois, until two o'clock p. m. the 14th day of December, A. D. 1908, for furnishing and laying 31,757 feet of drain tile ranging in size from 8-inch to 30-inch diameter.

Bids must be accompanied by cash or certified check equal to 10 per cent of the amount of the bid. Contractor will be required to file bond in the amount of 50 per cent of the estimated cost of the work. Plans and specifications can be seen at the office of the Harman Engineering Co., 120 Fredonia Ave., Peoria, Illinois. Copy of specifications and form of bid may be procured by application to the Engineer. Payments will be made in cash on monthly estimates. Works to be completed on or before the first day of November, A. D. 1909.

Commissioners reserve the right to reject any and all bids.

ZEALY M. HOLMES,

ALONZO M. ROOT,

IRVING J. CASE,

Commissioners.

HARMAN ENGINEERING CO., Engineers, 120 Fredonia Ave., Peoria, Ill.

WATER WORKS AND SEWERS.

Covington, Ga.

Sealed proposals will be received by the Chairman and Board of Commissioners of the City of Covington, Ga., until 3 p. m., December 2, 1908, for the construction of water and sewerage systems in and for the city of Covington, Ga., and furnishing all necessary materials for same.

Waterworks system will embrace approximately 400 tons of 6 to 10-in. cast iron pipe, with necessary valves, hydrants, etc., one 15x110 stand pipe, two compound pumping engines, one turbine pump and motor, brick pumping station, settling basin and clear water basin.

Sewerage system will embrace approximately 5 miles of vitrified clay pipe sewers from 6 to 15 ins. with all necessary man-holes, flush tanks, etc.

Plans, profiles, etc., may be seen at the office of the chairman of the Board of Commissioners and copies of the specifications, forms, etc., may be obtained from the engineers or chairman.

The right is reserved to reject any or all bids.

C. C. BROOKS,

Chairman Board of Commissioners.

J. B. MCRRARY & CO. Engineers,

Empire Bldg., Atlanta, Ga.

U. S. ENGINEER OFFICE, CHICAGO, Ill., Nov. 2, 1908. Sealed proposals for pile pier construction and removal of old pier in Michigan City Harbor, Ind., will be received at this office until 10 a. m., Dec. 12, 1908, and then publicly opened. Information on application. THOS. H. REES, Mayor, Engineers.

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From La Ligua to Copiapo, an extension of approximately 680 kilometers—all within the Republic of Chile.

Proposals should be addressed to the Minister of Public Works, Santiago, Chile, or to the Legation of Chile, Washington, D. C.

The Legation at Washington will furnish all particulars to contractors desiring to bid upon the work. The date for opening the bids by the Minister of Public Works in Santiago, Chile, is Feb. 1, 1909, for the La Ligua-Copiapó Railway.

STEEL WORK.

Madison, Wisconsin.

The Wisconsin Capitol Commission invite proposals for furnishing and erecting the Steel Work of the South Wing and Central Portion of the State Capitol now building at Madison, Wisconsin. The same is to be executed according to the plans and specifications and under the supervision of Geo. B. Post & Sons, Architects, 347 5th Ave., New York.

All bids must be on blanks furnished and accompanied by a certified check of 5 per cent of their amount, made payable to the order of the Capitol Commission. This shall be forfeited in case the contract is awarded to the maker and he fails within ten days to execute contract and furnish bond as provided for in the specifications.

All proposals must be enclosed in properly endorsed envelopes and delivered to the undersigned on or before noon of Friday, December 18, 1908.

LEW F. PORTER,

Secretary of Capitol Commission.

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Astoria, Oregon.

Sealed bids will be received until noon, December 21, 1908, at the office of the Water Commission in Astoria, Oregon, for furnishing the material and constructing about 12,000 feet of 24-inch concrete water pipe, and about 1,300 feet of steel water pipe and furnishings, according to specifications on file in the Water Commission Office in Astoria. All bids to be accompanied by certified checks for ten per cent of the amount of the bid. The right is reserved by the Water Commission to reject any or all bids.

CITY WATER COMMISSION,
C. S. WRIGHT, Chairman.

SEWER SYSTEM.

Hobart, Okla.

Sealed proposals will be received by the City Clerk of Hobart, Okla., up to 8 p. m. of 8th day of December, 1908, for furnishing material and constructing an extension to Sanitary Sewer System of said city. The following are the approximate quantities:

- 910 ft. of 12-inch concrete or vitrified clay pipe.
- 1,900 ft. of 10-inch concrete or vitrified clay pipe.
- 13,080 ft. of 8-inch concrete or vitrified clay pipe.
- 31 manholes.
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JESSE FIELD, City Clerk,
O. E. NOBLE, City Engineer.

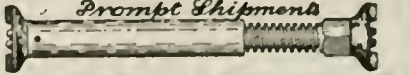
STEEL TANK AND TOWER.

Gridley, California.

Sealed bids for erecting a steel tank and tower for the City of Gridley, Butte County, California, will be received at the office of the City Clerk of Gridley up to the hour of 12 m., on Monday, the 14th day of December, 1908. Printed copies of the specifications for the above tank and tower, printed forms for proposals and printed copies of the complete advertisement may be obtained on application to the office of Engineering-Contracting, 355 Dearborn street, Chicago. Each bid must be accompanied by a certified check payable to the President of the Board of Trustees of the City of Gridley, to at least 5 per cent of the amount bid. The Board reserves the right to reject any and all bids. All bids submitted must be according to the statutes of the State of California.

F. G. MOESCH, City Clerk.

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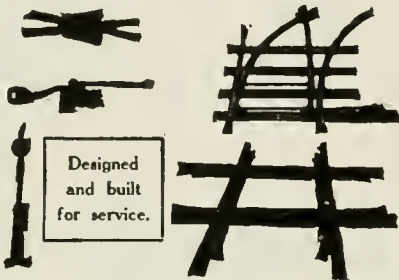
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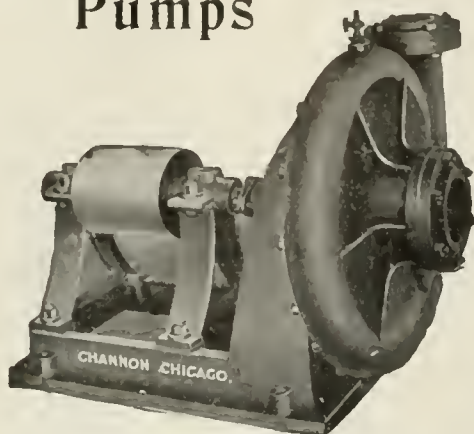
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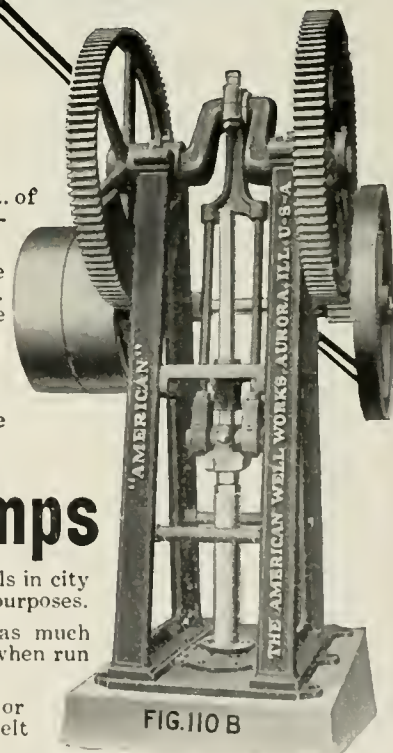
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Analysis Showing That the Panama Canal Is Certain to Cost at Least \$210,000,000, or 50 Per Cent More Than Originally Estimated.

Work on the Panama Canal has now progressed so far that an accurate forecast of its minimum finished cost is possible. We have made a careful analysis of the data in all the reports from the first to the latest. We find that \$85,000,000 have already been expended for plant sanitation, supervision, civil government, excavation, etc., on the Isthmus, since the United States began its work there. This does not include the \$40,000,000 paid to the French company nor the \$10,000,000 paid to the Panama Republic.

Of this \$85,000,000 only \$31,000,000 represents expenditure for engineering, labor and materials used in excavation and construction. In return for this \$31,000,000, the government can show little more accomplished than about 41,000,000 cu. yds. of excavation. Hence the excavation has cost nearly 80 cts. per cu. yd., not including plant amortization. The cost per cubic yard of excavation has increased each year, and is almost certain to increase still more, for several reasons, which we shall give later. But, assuming only the 80 ct. cost per cubic yard for the remaining 74,000,000 cu. yds. of excavation, and adding only the estimated cost of locks and dams, we find that the grand total will foot up to \$211,229,000, which is 50 per cent in excess of the estimated cost under which this vast work was begun! This \$211,229,000 is a conservative estimate, for it is altogether likely that the locks and dams (scarcely begun as yet) will also overrun as much as the excavation has overrun. If this occurs, we can now safely predict that the finished Panama Canal will cost \$240,000,000.

No engineering journal should ever attempt an estimate of this kind without the most thorough analysis of the recorded costs. While ENGINEERING-CONTRACTING has long foreseen that the cost of the Panama Canal would greatly exceed what the American people have been led to believe would be its cost, still it has seemed best to await developments before publishing facts that are so damning a criticism of the administration of the Canal.

We shall first present a tabulated analysis of what the Panama Canal had cost up to the close of the fiscal year, June 30, 1908. The report does not give the figures analyzed in this manner. Indeed, the effort seems to have been made to present the figures in such fashion as to conceal the real facts.

For this reason we have had to give the item of plant in round numbers, since the reports lump together plant and supplies in such a way that the precise amount of plant cost is not readily ascertainable.

The following is our own tabulation of

the cost of the entire work up to June 30, 1908, taken from the chairman's report:

Buildings	\$ 9,824,089
Waterworks, sewers and paving for Colon and Panama.....	2,237,132
Waterworks, sewers and roads for Canal Zone.....	3,533,618
Civil government and sanitation and hospitals	11,767,510
Equipment and plant (about)...	20,000,000
Panama R. R., loans, purchase of stock, re-equipment, etc.....	4,752,600
Two steamers	1,550,000
Construction, engineering and administration	30,908,049

Total expenditures\$84,572,998

This represents what has been spent, and, as previously stated, it covers only a small part of the actual excavation—about one-third—and practically none of the locks and dams.

The excavation done by the Americans up to June 30, 1908, amounts to 40,923,533 cu. yds., out of a total that will exceed 115,000,000 cu. yds. according to the report of a year ago. Let us assume that the plant, the buildings, etc., will cost but little more than has already been expended, which is leaning far on the side of charity to the Canal administration. Let us assume that the civil administration and sanitation will cost no more per annum in the next four years than it now costs, namely, \$2,000,000 per annum. Let us assume that the locks and dams will be built at a cost not exceeding the original estimate. Let us assume that the total excavation will cost no more per cubic yard than it is costing right now. Then we shall have the following conservative estimate of the total cost of the finished Panama Canal:

115,000,000 cu. yds. excavation at 80 cts. (including engineering, etc.).....	\$ 92,000,000
Plant and equipment.....	20,000,000
Buildings	10,000,000
Waterworks, sewers, roads, etc., Colon and Panama.....	3,250,000
Waterworks, sewers, roads, etc., Canal Zone	3,500,000
Civil government and sanitation.	20,000,000
Panama railroad	5,000,000
Two steamers	1,550,000
Land damages	500,000
Locks, dams and breakwaters as per original estimate.....	55,429,000

\$211,229,000

The last item of \$55,429,000 is quite as likely to overrun the original estimate as the other items have already overrun. In fact it has recently been decided to widen the locks by 10 ft., which will largely increase their cost. But if only the same percentage of excess cost, namely 50 per cent, be applied to this item of locks, dams and breakwaters, it will add another \$28,000,000, bringing the grand total to the vast sum of \$239,000,000. This will make the actual cost of the lock canal practically

equal to the estimated cost of the sea level canal, which was \$247,000,000.

For the benefit of those of our readers who may not have at hand the original estimate of the cost of the lock canal, as prepared by the consulting engineers, we give the following tabulation:

Original Estimated Cost of Lock Canal.

Breakwaters in Limon Bay....	\$ 5,300,000
Channel in Limon Bay.....	1,215,000
Limon Bay to Gatun Locks....	3,921,000
Gatun Locks, including excavation and backfilling.....	15,691,000
Approach walls to Gatun Locks.....	500,000
Gatun dam and spillway.....	7,788,000
Gatun to Obispo.....	5,005,000
Obispo to Pedro Miguel.....	43,337,000
Pedro Miguel Locks, including excavation and backfilling....	6,988,000
Approach walls to Pedro Miguel Locks	300,000
Pedro Miguel to Sosa Locks...	420,000
Sosa Locks, including excavation and backfilling.....	13,092,000
Approach walls to Sosa Locks..	450,000
Sosa Locks to deep water in Panama Bay	1,939,000
LaBoca dam	1,675,000
Ancon-Sosa and Ancon-Corozal dams	1,645,000
Diversion channels between Obispo and Pedro Miguel...	850,000
Diversion channel and regulating works at Ancon.....	275,000
Diversion of Panama railroad..	3,700,000
Movable dams at ends of summit level	2,000,000
Land damages	300,000
	\$116,421,000
Administration, engineering and contingencies, but not including interest during construction, sanitation or expenses of Zone government	\$ 23,284,200

Total estimated cost.....\$139,705,200

This estimate is based on the unit prices adopted by the Board of Consulting Engineers, the same unit prices being used for the estimate made for a sea level canal. These unit prices varied for different sections of the canal, the prices for earth running from 15 cts. per cu. yd. for dredged earth to 40 cts. for dry earth, and from 70 cts. to about \$1.25 per cu. yd. for rock.

Regarding these prices the Board had the following to say:

"The unit prices to be applied to the various items of work entering the completion of the canal have been formulated by the Board after most careful deliberation upon all the conditions affecting the actual prosecution of the work, including climatic effects, inefficiency of available labor, the distance of centers of supplies, the present condition of the various incomplete excavations, the general experience of the Isthmian Canal Commission since its creation, and other influences peculiar to

the circumstances which will surround the execution of work in the field to its completion. It has been the intention of the Board to make these prices liberal, so as to remove as far as possible any probability of the ultimate cost of the work being greater than that estimated, and it is believed that they are sufficiently liberal to accomplish the purpose."

"Sufficiently liberal to accomplish the purpose"! With the excavation only one-third done, with dams and locks only just begun, the work has cost \$85,000,000, leaving but a meagre \$55,000,000 with which to complete the work within the amount that the American people had expected to pay. The locks and dams alone will cost that \$55,000,000. The remaining 74,000,000 cu. yds. of excavation will cost \$59,000,000 at the very least.

In all probability, the cost of excavation will continue to increase, for the following reasons:

First, because the percentage of rock is steadily increasing, as the cuts grow deeper.

Second, because government employees grow less efficient as time goes on and the "new broom" feeling wears off.

Third, because earth slides will become more frequent and more damaging as the cuts increase in depth.

Up to the present, about 60 per cent of the excavation in the great Culebra cut has been rock. This percentage is steadily increasing, and, in addition to this reason for increased cost of excavation, much of the rock in the lower strata will be harder than that hitherto excavated, if the geological reports are correct. A large part of the material to be dredged will be rock. All of which makes it evident that the material easiest to excavate has been removed, and that the material yet to be excavated will be of an increasingly difficult character.

The only work yet done on the locks, dams and breakwaters has been of a preparatory nature, consisting principally of less than 3,000,000 cu. yds. of excavation.

This, in brief, is the situation. Who is responsible for it, and how can further gross waste of public funds be prevented?

When the original Board of Consulting Engineers made their estimate of cost, undoubtedly some errors occurred, but the gigantic blunder was made when the government abandoned the idea of doing the work by contract and undertook to do it by its own forces.

Each of the chief engineers successively put in charge of the canal perceived, as he thought, a chance to win eternal fame by acting not only as chief engineer but as industrial captain of a great army of men. The result is precisely what every unbiased engineer acquainted with conditions has expected. Not one of the eminent chief engineers of the Panama Canal had ever been a constructing engineer, in the sense that a contractor is. The public failed to perceive the importance of this distinction,

and did not protest against permitting the actual construction to be placed in the hands of men utterly without the proper training or experience.

As well make the life long editor of a newspaper the stage manager of a theatre as put these engineers into the shoes of a contractor. A drama is a literary production, an editor is a skilled literary man, hence, the ignoramus would reason, no man could be better fitted to act as a theatrical stage manager than an editor. The ignoramus in the analogous Panama Canal reasoning has been the public.

Aside from this blunder, there is the fundamental error involved in ever attempting to do public work of any magnitude by forces directly in the government employ. So long as human nature remains as it is, the average laborer working for a government will not work as faithfully as he will work for a private individual or corporation.

If the present waste of public funds is to be checked, the first step should be to appoint a board analogous to a board of directors on a railway. This board should not be engaged in the actual details of canal construction, but should receive the reports of the various departments, and perform the various functions belonging to a board of directors. With a broad knowledge, and entirely unbiased by personal motives, such a board would act in behalf of the stockholders of this great enterprise, the citizens of America.

The next step should be the award of contracts for the completion of the canal, the work on which is really only just begun, since 66 per cent of the excavation and nearly 100 per cent of the masonry remain to be done.

The existing plant should be turned over to competent contractors, either under unit price contracts or cost-plus-a-fixed-fee contracts, or both, as the board of directors might decide.

In any event, a proper system of unit cost keeping should be installed, and public reports should be made at frequent intervals, so that the "stockholders" in this enterprise would know exactly what they are getting for their money. As it now stands, it may be that proper cost keeping systems are in use on the Isthmus, but, if so, there has been a most cunning attempt to conceal the fact in the reports that have been made public. Familiar as we are with all kinds of cost keeping systems and lack of system, we do not recall ever having seen reports of the cost of public work so unsatisfactory as are those on the construction cost of the Panama Canal. No attempt has ever been made in these reports to show itemized analyses of the unit costs. No estimates have been prepared to show what the probable cost of the finished canal will be, based upon what the unit costs now are. In brief, the country has really been kept in the dark as to the true efficiency of the organization in charge of the canal

work. A lion roar has been raised from time to time about the astonishing amount of excavation yardage being moved at Panama, but not a mouse whisper about its unit cost.

A year ago, in the midst of the greatest noise about the yardage that had been excavated at Panama during the previous year, the Northern Pacific railway quietly announced in its annual report to its stockholders that the contractors excavating earth and rock for the N. P. had moved a greater yardage than had been moved at Panama.

The newly elected President can begin his administration in no more auspicious manner than by reorganizing the construction administration of the Panama Canal along the lines universally adopted by the great railway systems of this country: first, by appointing a board of directors; second, by confining the chief engineer to the du-

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Standard Designs for Reinforced Concrete Bridges of the Illinois Highway Commission With Some Details of Cost.

Reinforced concrete highway bridge construction is being widely advocated by the Illinois Highway Commissioner, Mr. A. N. Johnson, State Engineer. To encourage the building of such bridges the Commis-

he used at very reasonable cost and that for longer spans a reinforced concrete floor does not add an excessive amount to the cost of the bridge.

Spans Under 18 ft.—For spans under 18 ft. in the clear a plain reinforced concrete slab is used for the floor, the principal reinforcement running from abutment to abutment. Reinforced concrete side rails are used for this class of bridge and are considered preferable to pipe or angle rails

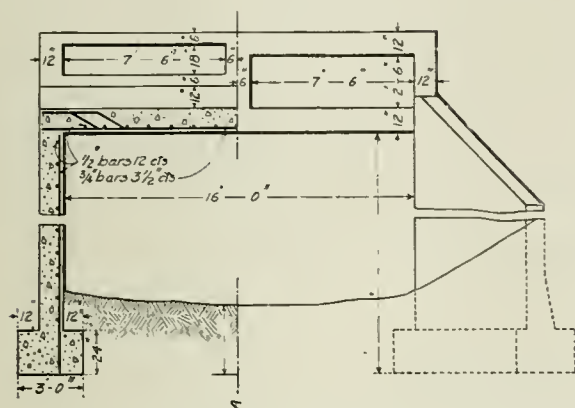


Fig. 1—16-Ft. Span Reinforced Concrete Bridge.

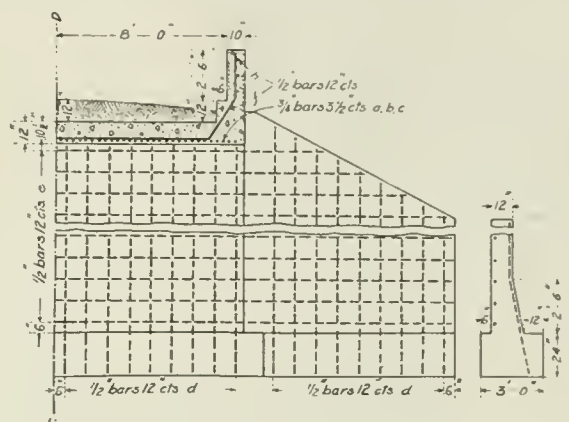


Fig. 2—Cross Section and Elevation of Abutment.

ties ordinarily exercised by the chief engineer of a railway; and third, by putting all the remaining construction under contract with the least possible delay.

Five contracts amounting to nearly \$6,000,000 have been let recently for work on the New York State Barge Canal. The contracts and the successful bidder were as follows: Contract 40, improvement of Erie canal from Lockport to Sulphur Springs guard lock, to the United Engineering & Contracting Co., New York, for \$2,166,298. Contract 41, east of Rochester, to Butler Bros. Hoff Co., New York, for \$281,330. Contract 46, from Fox Ridge, Cayuga county, to Salem, Wayne county, to the Kinser Construction Co., of Fort Edward, N. Y., for \$1,212,833. Contract 47, in Cayuga county, to the Crowell & Sherman Co., of Cleveland, O., for \$1,262,638. Contract 68, construction of dams and locks in the upper Hudson, to Shanley-Morrissey, Inc., of New York, for \$1,018,323.

The highest average record for one day by the steam shovels of the Central Division of the Isthmian Canal was made on Oct. 28, when 49 shovels excavated 62,396 cu. yds. of material.

sion has worked out two general standard designs according to one or the other of which it prepares plans for individual structures. These general designs are given in the second annual report of the Commis-

because of their strength and durability. Figures 1, 2 and 3 show the plans for one of these bridges. In constructing these bridges the report notes that:

"Where a number of slab bridges under

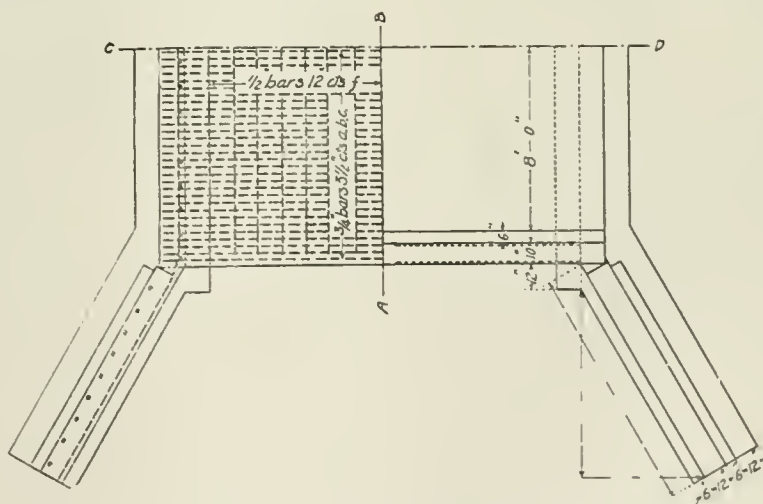


Fig. 3—Floor and Abutment Plan.

sion, and from this report we abstract the following description and cost data.

The Commission recommends reinforced concrete for all spans under 50 ft. in length. It has found that for spans under 40 or 50 ft., reinforced concrete can

20 ft. in span are built the same season, it may prove cheaper to use I-beams to support the slab until the concrete has set than to use mud sills and timber posts. If this is done the abutments are carried up as usual to the height of the under side

of the floor, pockets being left for the I-beams; these pockets being about 6 ins. wide and deep enough so that when opposing wedges are placed under the ends of the I-beams the top flanges of the I-beams will be 2 ins. below the level of the bottom of the slab. Two-in. planking

necessary for appearance and economical placing in the rail forms. For spans over 30 ft., and particularly for wide roadways, the girders become heavier, and it has been found necessary to design the girders with a heavy coping, giving the girders a T-beam section. A number of girder bridges

The aggregate value of all the products obtained from the distillation of coal in gas works and retort ovens in 1907 in the United States was \$73,573,004.

The high record for steam shovels during the month of October in the central

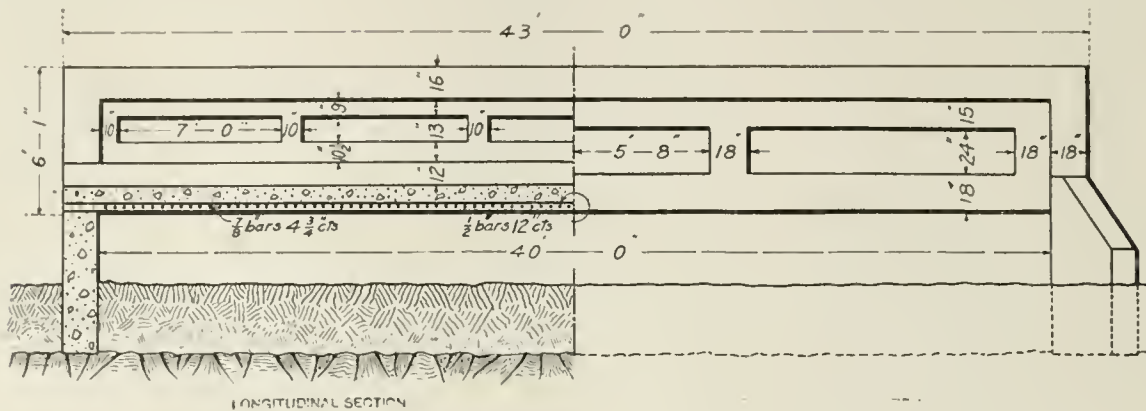


Fig. 4—Longitudinal Section and Elevation of Experimental Reinforced Concrete Bridge.

is used to support the slab. When the concrete in the slab and rails has hardened sufficiently the wedges are removed and the floor forms drop down; the planks are drawn out at the sides and likewise the I-beams through the pockets in one of the abutments. The pockets are then

of this character have already been built and the plans drawn for several which will be built the coming season.

Figures 4, 5 and 6, showing the details of design of the experimental bridge built at the Southern Illinois Penitentiary at Mc-nard, illustrate this type of construction.

division of the isthmian canal was made by shovel No. 230, at work in the Culebra District. According to the Canal Record this shovel excavated 58,483 cu. yds. in 27 days, an average of 2,166 cu. yds. per day. Shovel No. 250, working 20 days in the Empire District and 7 days in the

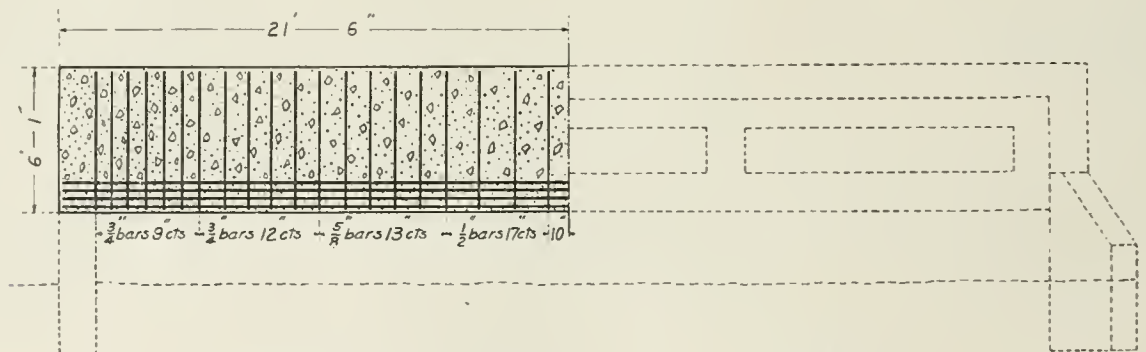


Fig. 5—Longitudinal Section of Girder Showing Stirrups.

filled with concrete. The I-beams and planks may be used repeatedly."

Spans from 18 to 42 ft.—For spans ranging in length from 18 to 42 ft. the concrete rails have been designed as girders to carry the load to the abutments. The floor in this case is a reinforced concrete slab, the main reinforcement running from girder to girder. The floor is suspended to the girders by bending every third floor bar up into the girders. This type might well be classed as a reinforced concrete through girder bridge. This has proved to be a very economical design. The forms are very simple and much of the lumber remains uncut. The bending moment in the floor slab is independent of the length of the span, and consequently the amount of concrete and steel in the floor slab, for a given width of roadway, remains constant per foot of bridge. The rails or girders for bridges 18 to 30 ft. in span contain but little more concrete than would ordinarily be

The dimensions, quantities and costs for a number of the bridges built on the Commission's plans are given in the accompanying table compiled from figures given in the report:

Culebra District, excavated 55,535 cu. yds., an average of 2,056 cu. yds. per day. Both of these shovels break the high record formerly held by shovel No. 256.

Span in feet.....	Height of Abutment, feet.....	Width of Roadway, feet.....	Superstructure.		Substructure.		Total.		Cost	Cost per Lineal foot.....
			Concrete, cubic yards.....	Steel, pounds.....	Concrete, cubic yards.....	Steel, pounds.....	Concrete, cubic yards.....	Steel, pounds.....		
16	12	18	23.5	3,142	75.2	2,385	98.7	5,527	\$1,146	\$71.64
20	12	18	23.5	3,142	75.2	2,385	98.7	5,527	245	30.62
24	12	18	23.5	3,142	75.2	2,385	98.7	5,527	120	30.00
28	12	18	23.5	3,142	75.2	2,385	98.7	5,527	610	46.66
32	12	18	23.5	3,142	75.2	2,385	98.7	5,527	460	16.72
36	12	18	23.5	3,142	75.2	2,385	98.7	5,527	640	42.66
40	12	18	23.5	3,142	75.2	2,385	98.7	5,527	2,221	55.52
44	12	18	23.5	3,142	75.2	2,385	98.7	5,527	1,380	46.00
48	12	18	23.5	3,142	75.2	2,385	98.7	5,527	695	57.91
52	12	18	23.5	3,142	75.2	2,385	98.7	5,527	123	41.00
56	12	18	23.5	3,142	75.2	2,385	98.7	5,527	419	34.08
60	12	18	23.5	3,142	75.2	2,385	98.7	5,527	262	13.10
64	12	18	23.5	3,142	75.2	2,385	98.7	5,527	995	33.16
68	12	18	23.5	3,142	75.2	2,385	98.7	5,527	750	53.57
72	12	18	23.5	3,142	75.2	2,385	98.7	5,527	1,154	38.46
76	12	18	23.5	3,142	75.2	2,385	98.7	5,527	390	39.00
80	12	18	23.5	3,142	75.2	2,385	98.7	5,527	409	25.56
84	12	18	23.5	3,142	75.2	2,385	98.7	5,527	198	16.50

Cost of Molding Concrete Sewer Blocks

The cost of molding several thousand concrete blocks to be used in sewer construction at Halifax, N. S., is given in the "Canadian Engineer," from which we rearrange and further analyze the figures as follows:

The work involved the mixing and molding of 356.35 cu. yds. of concrete in 1,341 batches of 7.17 cu. ft. each. The cost of the molded blocks was as follows:

Item.	Total.	Per cu. ft.
5,050 hrs. labor at 16 to 24 cts.....	\$ 838.76	\$0.087
1,733 bushels cement at 80 cts.....	1,386.40	0.144
2,850 bushels sand at 6 cts.	171.00	0.017
2,684 bushels gravel at 6 cts.	141.04	0.014
5,364 bushels stone at 7 cts.	375.48	0.038
Paper	26.82	0.0028
Soap	17.85	0.0018
Coal	48.95	0.0050

Total\$3,006.30 \$0.3096

The cost of the blocks complete was

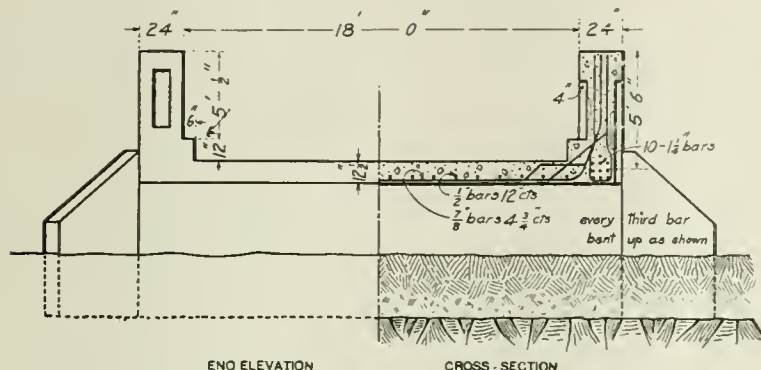


Fig. 6—Experimental Reinforced Concrete Bridge of Illinois Highway Commission.

thus 31 cts. per cu. ft. or \$8.37 per cu. yd. This cost includes cleaning molds, moving and storing blocks and all expenses incident to the cost of manufacture except the cost of the water used.

The total production of coal tar in 1907, in the United States, as reported to the U. S. Geological Survey by 488 companies, was 103,577,760 gallons, valued at \$2,651,527, as against a production of 80,022,043 gallons, valued at \$2,176,944, reported in 1905 by 521 companies; from which it appears that while the production of coal tar increased 23,555,717 gallons, or 29 per cent, the value increased only \$474,583, or 22 per cent. The price for tar has shown a steadily declining tendency since 1903, when the average price reported to the Survey was 3.49 cents per gallon. It dropped to 3.04 cents in 1904, to 2.72 cents in 1905, and to 2.6 cents in 1907. The yield of tar per ton of coal consumed in 1907 ranged from 6.34 gallons in Pennsylvania to 19.63 gallons in Missouri, the average for the entire United States being 9.04 gallons. The price ranged from 2 cents in Illinois to 10.3 cents in Oregon.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Methods and Costs of Driving the Hot Time Lateral of the Newhouse Tunnel.*

BY HENRY M. ADKINSON.†

S. A. Knowles, now superintendent of the Boston Consolidated mine at Bingham, Utah, in driving the 12x12-ft. Newhouse tunnel at Idaho Springs, Colo., advanced the face a total of 2,925 ft. in 12 months, or at an average rate of 244 ft. monthly, and at an average breaking cost of \$21.45 per foot, as was carefully described by H. Foster Bain in the Journal of April 19, 1902. His record of 7½ ft. average advance per shift in the 6x9-ft. Central tun-

ness in bores of smaller dimensions. He has described to me, and given me permission to present in some detail, the method he employed in driving an adit 5x7½ ft., the normal size of mine workings. By this method he made monthly advances of more than 250 ft. with a force of 11 men, while the cost of breaking and tramping was approximately \$13.50 per ft.

The notable results briefly stated above were obtained in the work of driving the Hot Time lateral, a connection between the Newhouse tunnel and the 2,200-ft. level of the Old Town shaft, at Idaho Springs, Colo. During 1907, Mr. Knowles pushed this connection from a length of 1,834 ft. on Jan. 1, 1907, to a length of 4,333 ft. at the end of the year, or a total distance in the twelve months of 2,499 ft. The rate of advance of the different months was: January, 1907, 253 ft.; February, 237; March, 84; April, 185; May, 263; June, 251; July, 200; August, 200; September, 254; October, 224; November, 260; December, 88; total advance, 2,499 ft.; average monthly advance, 208¼ ft.; average monthly advance, excluding March, April and December, 238 feet.

The adit was driven through granite, gneiss and schist, very hard to drill and so tough and tenacious that it broke badly. There were no soft seams nor any defined walls to follow. The fact that there was no timbering to be done; that the ground was not wet enough to require rubber coats; and that the size of the bore, 5x7½ ft. in the clear above the rails, corresponded so closely with the usual size of mine workings, made the problem, in all essential conditions, the counterpart of the problem hundreds of properties are working on every day. For this reason the following details of this rapid progress, made at such a reasonable cost, are the more interesting and valuable.

DRILLING AND BLASTING THE HOLES.

The machineman and helper set up the drill without waiting for the dirt from the previous shots to be cleaned up. The set-up was on a cross-bar placed high enough in the drift and far enough away from the face to allow the upper row of holes (1, 2 and 3 in the diagram) to be started close to the back and to be drilled with very little rise in their depth of six feet. The muckers at work loading the cars gave what additional assistance the drill crew required in setting up. The accompanying diagram illustrates the position and direction of the holes.

From the first set-up of the cross-bar at position A, all the holes except the three bottom ones, the "lifters," were drilled.

nel of the Big Five company, at Idaho Springs, was detailed in a pamphlet published by the Leyner Engineering Works Company, of Denver. Lindsay Duncan published in ENGINEERING-CONTRACTING, June 20, 1906, the details of cost in Mr. Knowles' work at the west end of the Gunnison irrigation tunnel of the Reclamation Service, in Montrose county, Colo., where advances of 100 ft. in five days were made in adobe ground.

In reading these descriptions of high-pressure work the mine manager is too apt to dismiss the subject with the thought that such rates of progress are possible in bores of the larger dimensions, but are not possible in the kind of work he is carrying on, where the smaller drifts and crosseuts offer increasing difficulties to rapid advance, by making impossible the working of the large force of men which in his experience is the only means to this end. Mr. Knowles has demonstrated that it is possible to make equally satisfactory prog-

*Slightly condensed from the Engineering and Mining Journal.

†Mining engineer, Telluride, Colo.

*Work was held up by the Old Town company.

*Work was completed and connection made with this 88 feet.

Holes 1, 2, 3, 4, 5 and 6 were drilled with the machine above the cross-bar, to which it was attached directly without any arm. When these holes were finished the drill was swung under the bar and all others except the three "lifters" were drilled from this position. By the time these 12 holes were completed the muckers had cleaned up the face. Then the bar was torn down and set up in position B, close to the bottom, so that the bottom holes might be put in after the same manner as the back holes. The usual round was 15 holes, each 6 ft. or more deep and having a diameter of $1\frac{1}{2}$ in. at the bottom. When the ground showed any peculiarities which indicated that another hole or two would be necessary in order to break the ground well these were drilled where needed. The ordinary round contained 90 ft. of drill holes, so that to make the set-ups, drill the round, tear down, load and shoot the holes required the full 8-hour shift.

Mr. Knowles used the Model 6, Water-Leyner drill. The use of hollow steel flushed with a stream of water makes it possible to keep the bottom of the hole

avoided, the explosion was equally effective in breaking the ground, and the gas was less trying on the men, so that the muckers were able to get to work sooner after the holes were blasted. No definite amount of powder was assigned to any of the holes, the matter of loading being left to the judgment of the machinemen, except that holes 8, 9, 11, 12, 13, 14 and 15 were loaded more heavily than the others. In the process of loading, a full stick of powder was put in the bottom of the hole; next came another stick containing the fuse and a XXXXXX cap in its lower end, and after that what other powder was necessary. Experience showed that the greatest shattering took place in the ground nearest the primer, and for this reason it was placed as near the bottom of the hole as practicable. On this theory it would have been better to have placed the primer at the very bottom of the hole, but this was not done because the hard tamping of a primer against the rock might have exploded the cap prematurely and with fatal results. To increase still further the effectiveness of the ex-

that there is no economy in making a saving on explosives, and thus losing ground, after incurring the heavy expenses of labor, air and machines to drill the holes. The labor of mucking back was also saved by the judicious method of loading.

MUCKING AND TRAMMING.

When the last shot was fired compressed air was blown into the face and the smoke exhausted through a 12-in. ventilating pipe connected with a positive blower. The ventilating pipe was carried to within 100 or 150 ft. of the face, that being as close as it could be brought without endangering it. Thirty minutes after the shots were fired the air was clear enough to allow the muckers to begin work. There were three muckers, two of them loaded cars while the third trammed the rock to the point where the mule trains were made up. By alternating in this tramming work each mucker obtained a rest without any loss of time.

The mine cars used had a capacity of 36 cu. ft. and held about two tons of the rock handled. These cars were provided with roller bearings, and six to eight cars constituted a mule train. The muckers used No. 5 square-point, short-handled shovels, and in four or five hours the entire pile of muck was removed, about six or eight cars being handled per shift. From the preceding statement it will be seen that it required two muckers to load 8 or 10 cars per shift, while in Mr. Knowles' work in the Newhouse tunnel the same number of cars of the same size were filled by one mucker in one shift, and that, too, without any rest such as the tramming work afforded here. The variation is accounted for by the fact that the muckers were working in the Hot Time lateral under the handicap of the unavoidable interference by the drilling crew, which interference was a necessary accompaniment of double-shift work.

After clearing out all the dirt, the muckers laid what additional track was necessary. The tracking was of 20-lb. rails, laid on a 1-per cent grade, and until it was possible to lay the full lengths of rails the cars were run on the shoveling plats. The dirt was trammed by mule train through the Hot Times lateral to the Newhouse tunnel. This was a distance of 1,800 ft. in January, 1907, and a constantly increasing distance, until at the last the mule train hauled dirt 4,300 ft., or about four-fifths of a mile. From the junction of the Hot Time lateral with the Newhouse tunnel the cars were hauled by electric motor the remaining 12,000 ft. to the dump. For this latter service a transportation charge was made by the "Tunnel" company.

THE CREW AND THE WORK ACCOMPLISHED.

The full crew was composed of two machinemen at \$4 per shift each, two machine helpers at \$3.50 each, six muckers at \$3.50 each, and one foreman. The wages paid were higher than usual because the

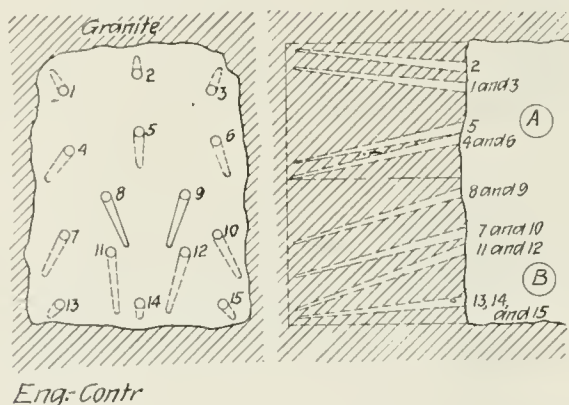


Diagram Showing Position and Direction of Drill Holes.

clear of cuttings, and the bit cool, so that each blow is struck full on the clean face of the rock. By using this drill the crew gained the time usually lost in scraping the hole, and in changing the steel frequently. The saving of this lost time, which in the aggregate consumes a large part of the drilling period, is one of the most important features of this work, and one to which Mr. Knowles ascribes a large part of his success. The power consumption in the use of a hammer type of drill, rather than a piston drill, was here a negligible quantity, since air was purchased at a flat rate of \$4 per shift.

As soon as the drilling was finished the machinemen loaded the entire round of holes. Shoveling plats (steel turn-sheets 4x5 ft. and $\frac{1}{2}$ in. thick) were laid in the drift for a distance of about 25 ft. back from the face.

Mr. Knowles used a 10 per cent gelatine of the Du Pont brand; 60-per cent dynamite was also tried, but the results were not enough better to compensate for the extra cost. By using the plastic gelatine any possible air spaces in the holes were

plosion the strongest cap obtainable was used.

Each round broke from 4 to $1\frac{1}{2}$ ft. of ground. If, after the round was fired, it chanced that some of the shots did not break the entire hole, or misfired, these holes were reloaded and fired again before the work of mucking began. The holes were fired in the following order: Nos. 8, 9, 11, 12; then 5, 7 and 10; then 4 and 6; next 2, followed by 1 and 3, with 14, 13 and 15 at the last. The latter three holes, loaded more heavily than the upper holes, as previously noted, were fired in as close succession as possible, with 14 just before the others. The object of this was to throw the dirt back from the face with the last shots, and leave a space for the following set-up to be made without the extra labor of mucking back.

In this work of loading and firing the holes the important factor is the use of the gelatine with the most powerful detonator possible, thus breaking the ground in an effective manner and also reducing the amount of gases so that the work could be closely followed up. Mr. Knowles believes

best men were wanted on the work, and because the conditions under which they worked were very trying. At these higher wages the men were required to complete their allotted work before leaving, and if necessary they worked overtime, with no additional pay. On the other hand, they frequently completed their work before the expiration of the eight hours, and no objection was made to their leaving when they were through.

The day machineman and helper began work at the face at 8 a. m. They usually completed the round and fired by 4:30 p. m. The muckers on the night shift began work at 6 p. m. and completed their work within the eight hours, laying any necessary track in addition. The night drill crew came on at 8 p. m. and usually completed their round by 4:30 a. m. The day muckers began work at 6 a. m. and worked till the dirt was out. Thus it will be seen that both drilling and mucking went on simultaneously, and the set-ups were made with the pile of dirt in the face. Mr. Knowles recognized that this was not the cheapest method of driving the adit, since it would have been possible to save \$2 or \$3 per foot if the drill crews and muckers had worked alternately, and each crew had no interference* in its work. But in this work speed was the chief object sought and the difference in cost was not important. Mr. Knowles' work is characterized by rapid progress made under high pressure, rather than the striving for a minimum cost.

Nevertheless, when it is taken into consideration that the mucking crews were working under most unfavorable circumstances in respect to atmospheric conditions, and that in this work all the crews were crowded on account of the size of the drift, the cost per foot shows a very good figure. In order to analyze the costs during the period when the most rapid progress was made, the months of May to November, 1907, inclusive, are chosen. In these months the advance never fell below 200 ft. monthly, and ran as high as 263 ft., averaging 236 ft. per month for the entire seven months. During this time a total advance of 1,652 ft. was made at a total cost of \$22,186.36, or an average cost per foot of \$13.43. Mr. Knowles has kindly consented to my presenting the following cost per foot of the different items:

	Per lin. ft.	Per cu. yd.*
Labor	\$ 5.646	\$4.09
Air drilling	1.236	0.90
Air blowing	0.054	0.01
Explosives	2.828	2.05
Transportation	1.072	0.77
Supplies	0.784	0.56
Drill repairs	0.651	0.47
Blacksmith	0.545	0.40
Mules	0.112	0.08
Miscellaneous	0.500	0.36
Total	\$13.428	\$9.72

*Added by Editors of Engineering-Contracting.

The item of mules is for feeding and shoeing them.

IMPORTANT FACTORS OF THE WORK.

In examining the elements which entered into this work to make it the success that it was, we find a combination of several important factors which may have been used singly elsewhere, but which were here coördinated into a working whole with most gratifying results. It would perhaps be difficult to point to any one factor as preëminently noteworthy, but certainly, without the drilling of the holes in rapid time, the rest of the work would have gone for naught. The constant high pressure used at the drill made this machine especially effective. The use of a less gaseous, high-power explosive, such as the gelatine powder, combined with the strongest detonator, was a second factor which may not be lightly passed by. These factors both contributed in a great degree to the rapid breaking of the ground. In the removal of the dirt, the use of shoveling plats and wide, square-pointed shovels, instead of the commonly used round point, were very efficient agents in rapid progress. All these mechanical contrivances aided in no small measure in the work, but Mr. Knowles points to the very efficient work of his foreman, T. W. Grasser, as one of the most important elements in his success. Mr. Grasser has worked with him for years, and he put every ounce of his energy and foresight into the work, and worked diligently in order to bring the work to a successful conclusion. But, after all, a most effective agent was the wonderful *esprit de corps* which was developed in a picked crew of men doing a particular work. This kept them toiling not alone for the money reward, but also because of the determination not to be beaten by the other shift.

It is expected that work will be finished in about three months on the new gridiron now under construction at the La Boca marine shops of the Isthmian Canal. The gridiron is 300 ft. long, 50 ft. wide, and when completed will accommodate a vessel the size of the suction dredge Culebra, states the Canal Record. The foundations of the structure will be 44 concrete piers, placed 7 ft. apart and extending the full width of the gridiron. The piers will rest on solid rock and a layer of mud and silt, from 2 to 10 ft. deep, is being removed from the site. As the variation in the tide on the Pacific side of the isthmus is about 20 ft., the gridiron is so situated that a vessel, placed on it at high tide, will be entirely above water at low tide, so that work can be done on the hull between tides.

About 11,000,000 cross-arms for telephone and telegraph poles are used each year in the United States, according to figures of the U. S. Forest Service.

Cost of a 4,000 lbs. Blast.

On May 22, 1907, a large blast was made in the steam shovel workings of the Boston Consolidated Co., at Bingham, Utah. The material was a copper bearing porphyry. The steam shovels, excavating the ore, were working on the main point of rock which projects from the regular center of the mountain. Cuts had been made on both sides of this point, and a blast was made to straighten out the work.

A hole was put down 80 ft. with a No. 3 Keystone traction well drilling machine, using a 5½ in. bit. It was placed so that there was about 60 ft. of powder on the bottom of the hole. The hole was sprung with three boxes of 40 per cent Hercules dynamite, and then loaded with two tons of the same grade of powder. By surveys, before and after, it was shown that 12,000 cu. yds. of material were shattered so it could be excavated. The cost of the blast was as follows:

80 ft. of drill hole at 58c per ft.	\$ 46.40
150 lbs. dynamite for springing at 10½c.	15.75
4,000 lbs. dynamite at 10½c.	420.00
Fuse and caps	1.20
Labor handling powder and incidentals	17.25
Total	\$500.60

This gives a cost per cu. yd. of 4.1 cents for loosening this rock. For the springing 1¼ lbs. of dynamite was used for every 100 cu. yds. of material loosened, while for the entire blast about 0.35 lbs. of dynamite was used for each cu. yd., which is an economical blast, in spite of the fact that in loading the hole a little too much powder was put in the collar of the hole, thus throwing out some of the material, when it was only wanted to shatter it, so it could be excavated by the steam shovels.

This could have been prevented by springing the hole a little more, thus giving a larger chamber for the powder and keeping it out of the collar of the hole all together. The information regarding this blast has been taken from "Mines and Minerals."

The New York State Public Service Commission has granted the Pelham Park R. R. Co. and the City Island R. R. Co., New York City, permission to substitute a monorail line, to be operated by electricity, for the present horse car service. The route operated by the companies extends from City Island to Bartow Station, a distance of about three miles. The American Monorail Co. will install the system

Of the permits used for buildings erected last year, approximately 61 per cent were constructed of wood, and the remaining 39 per cent of fire resisting material, according to a report issued by the U. S. Geological Survey on operations in 19 leading cities of the United States.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

An Asphaltic Macadam Highway at Rye, N. Y., Built by the Petrolithic Process.

The building of a highway on the Atlantic coast by methods that have not been extensively used except on the Pacific coast is worthy of description.

Until very recently it has been impossible to secure asphaltic oil in the eastern

A still further development consists in the profuse use of water before and after the application of the asphaltic oil. Oil and water are commonly supposed to be so antagonistic that they should never be used together in road or street work. But the highway builders who have been developing the petrolithic process discovered that a much more perfect mixture of the asphaltic oil and the soil could be secured

the breaking up of this crust could be done with a rooter plow pulled by 4 to 6 horses. The old macadam was thus mixed with the soil from beneath. In many stretches, where the new grade line cut below the base of the old macadam, the macadam was shoveled up and removed entirely. Subsequently new stone ($\frac{3}{4}$ to $1\frac{1}{2}$ in.) was put on to a depth of about 2 or 3 ins., and mixed with the top soil.

A spring tooth harrow was used to break up the soil and to assist in mixing the materials, but the most effective method of mixing the asphaltic oil was the abundant use of water and the use of an ordinary road machine, as will be explained later.

The asphaltic oil was furnished by the Standard Oil Co. of New York, and con-



Asphaltic Macadam Construction on Boston Post Road at Rye, N. Y.

part of America at a price that made it possible to use the California methods of street and road construction without excessive cost. This condition has unquestionably delayed the more extensive adoption of California methods of road building.

Beginning originally with the surface sprinkling of earth roads with asphaltic oil, the trend of California road work has been steadily toward the more permanent construction. Following the surface sprinkling came the process of mixing the plowed earth and asphaltic oil to a depth of about 6 ins. and the thorough consolidation of the mass with a rolling tamper. This tamping process now known as petrolithic, soon developed further, the next step being the mixture of a 2 or 3 in. layer of broken stone or gravel with the top layer of soil and asphaltic oil.

simply by using water in abundance, for each globule of water appears to carry with it a certain amount of asphaltic oil, and thus "puddle" it into the minutest voids of the soil.

Through the village of Rye, N. Y., passes the celebrated Boston Post Road, which is subject to a very heavy automobile traffic. The motor cars had cut the macadam to pieces, in many places having worn it almost through to the soil beneath. The highway was so badly cut up that complete rebuilding was necessary, and it was resolved to make a roadway in which an asphaltic binder would be used. Two miles of roadway 20 ft. wide were accordingly rebuilt in the manner that will now be described briefly.

At first the old macadam was broken up with the picks in the rear wheels of a steam roller, but it was soon found that

tained about 70 per cent asphalt. It was delivered in tank cars containing steam coils, heated from a portable steam boiler, and pumped into a large wooden tank, whence it was drawn off into a small tank and heated to about 200° by means of a steam coil. The "oil" was then drawn off into a sprinkling wagon having a Glover oil sprinkling attachment, and hauled to the road. When the haul is two miles, the "oil" reaches the road at about 100°, which is hot enough for good sprinkling. Once it is on the road, the temperature matters little where the present method of using water is employed.

Although the specifications called for but $2\frac{1}{2}$ gals. of asphaltic oil, the contractors used 3 gals. per sq. yd. The amount of water sprinkled on was about twice the amount of asphaltic oil.

The method of mixing by harrows and

farm cultivators is described in such detail by Mr. J. C. Black, in an article that appeared in our Nov. 11 issue, that it is unnecessary to repeat it here, further than to call particular attention to the use of the road machine for mixing. The blade of a road machine, set at an angle, scrapes off a layer of the materials and casts them in a winrow to one side. On the return trip, the blade casts this "winrow" in the opposite direction. This rolling of the materials over and over acts like a pug mill, and produces a mixture of remarkable uniformity.

When the soil shows uniformly black, due to a perfect mixture with the asphaltic oil, the rolling tamper, drawn by four horses, begins its important work. The "iron sheep's feet" of the tamper sink into the loose material and begin the tamping action at the bottom. The tamping is continued until about 2 ins. of loose material remains on top, when the new broken stone is applied and mixed as above described, after adding the final coat of oil. The tamping is then continued until the surface is perfectly solid and is no longer penetrated by the feet of the rolling tamper.

If then thrown open to traffic the wheels of vehicles iron out the surface in a few days until it is as smooth as a table and looks like an asphalt pavement.

The appearance of the street at Rye is well shown in the accompanying photograph.

For spreading the broken stone a two-horse machine, "The 20th Century Grader," was used.

The contractors for this work at Rye, N. Y., were the Terralithic Road Co., Park Row Bldg., New York City.

The five track shifting machines in the Central Division of the Isthmian Canal during the month of October moved a total of 415,858 ft., or 78.8 miles of track, according to the Canal Record. In the Tabernilla district track shifter No. 5 moved 110,200 ft. or 20.9 miles, and No. 8 moved 70,064 ft. or 13.3 miles. Track shifter No. 7 moved 121,076 ft. in the Gorgona district and 4,158 ft. in the Empire district, a total of 125,234 ft., or 23.7 miles. No. 9 shifted 39,212 ft. of track on the Miraflores dumps and 6,388 ft. in the Empire district, a total of 45,600 ft. or 8.6 miles. No. 6 shifted 58,160 ft. of track on the La Boca dumps and 6,600 ft. in the Empire district, a total of 64,760 ft. or 12.2 miles. Of the total of 415,858 ft. of track shifted, 180,264 ft. or 34.2 miles, were moved in the Tabernilla district, 121,076 ft., or 22.9 miles, in the Gorgona district; 17,146 ft. of 3.2 miles in the Empire district; 39,212 ft. or 7.4 miles on the Miraflores dumps, and 58,160 ft. or 11 miles on the La Boca dumps.

The total production of crude petroleum in the United States in 1907 was 166,095,335 bbls., valued at \$120,106,749.

Methods and Cost of Constructing 990 Lin. Ft. of 15 Ft. Cement Walk at Nelson, B. C.*

The walk was built in three 330-ft. sections and was 14½ ft. wide with a 6-in. granite curb. The specifications were as follows:

Thickness: On business streets the walk shall be 6 ins. and on residential streets 5 ins. in thickness. This shall consist of a base and top finish. On business streets the base shall be 4½ ins. thick, and the top finish 1½ ins. thick; and on residential streets the base shall be 3¾ ins. and the top finish 1¼ ins. in thickness.

Rolling and Tamping.—The whole surface of the sub-grade shall be consolidated by rolling or ramming until it is thoroughly solidified to the complete satisfaction of the city engineer. The sidewalk sub-grade when completed and rolled as above, must conform to the required cross section of the sub-grade formation.

Proportions.—Upon the sub-grade a bed of concrete shall be laid to the depth and width as per contract. The base shall consist of not less than 1 part best Portland cement, of an approved brand, to 8 parts of the aggregate, which shall be made up of 5 parts of broken rock, 1 part gravel or smelter slag, and 2 parts sand, or otherwise as directed by the city engineer. The top finish shall consist of 1 part best Portland cement to 2½ parts of the aggregate, which in this case shall be made up of crushed rock screenings all to pass through a ¾-in. circle, and or clean sharp sand, and or smelter slag, in proportion as directed by the city engineer. The method of measuring the cement, sand, gravel, etc., shall be to the approval of the city engineer.

Laying and Ramming.—The concrete shall be laid in strips or blocks 5 ft. in width, every alternate block being left out until the block on either side shall be sufficiently set to allow of the removal of the side molds. The base shall be first laid to the required thickness, and thoroughly rammed with approved rammers, not to weigh less than 20 lbs. The top finish must in all cases be laid before the base has had time to set. As soon as a block is started, work must go on continuously until it is finished, and in no case must a block be left unfinished over night; and if for any reason a block should be so left, the concrete must be taken out by the contractor and at the contractor's expense, and the block restarted. Any concrete mixed and left unused over night must be discarded. On business streets the sidewalks shall have a 2 per cent slope towards the curb. In like manner the alternate strips shall then be filled up to grade. A strip of ½ in. lumber must be left between the blocks to prevent adhesion. After the concrete is sufficiently set (to be determined by the city engineer) these ½-in. strips shall be

*Rearranged from the "Canadian Engineer."

removed, and the crack or opening so formed filled to within 1½ ins. of the surface of the sidewalk with coal tar or paving pitch, and the concrete edges neatly rounded off and jointed with a proper bronze jointer tool, made for the purpose. Only one of the above joints will be necessary to each 75 ft. length of sidewalk; the balance may be made by leaving a strip of tar paper between the blocks, and finishing with jointer tool.

Finishing.—Each concrete block or strip of sidewalk shall be divided off into three sections by lines made by pressing a ½-in. board down through the top finish before it is thoroughly set. Each section so formed shall be neatly floated and trowelled, and rolled with a dot roller to within 2 ins. of its edges, which must be properly rounded off, and jointed with a special jointer tool for that purpose. All lines must be straight and square, and all finishing work must be done neatly, and to the complete satisfaction of the city engineer.

The wages paid and the prices of materials were as follows:

Foreman per 9-hour day.....	\$6.00
Finishers per 9-hour day.....	4.00
Laborers per 9-hour day.....	3.00
Team per 9-hour day.....	7.00
Extra wages per 9-hour day.....	.50
Cement per barrel.....	3.50

The costs of the three sections of walk were as follows:

Item	Sec. 1.	Sec. 5.	Sec. 6.
Wages	\$618	\$544	\$646
Cement	478	459	500
Team hire	155	96	152
Sundries	58	65	42

Totals

The cost of 990 ft. of walk was thus:

Wages	\$1,808
Cement	1,437
Team hire	403
Sundries	165

Total

This total includes hauling 590 cu. yds. of material for filling at a cost of 80 cts. per cubic yard or a total of \$472, which subtracted leaves \$3,341 as the cost of preparing sub-base, setting 990 lin. ft. of curb-stones and constructing 990 lin. ft. of 14½-ft. walk, or 14,310 sq. ft. of walk. This gives a cost for walk of 23¼ cts. per square foot.

The lumber production in 1907 was the largest ever recorded in the United States, according to figures recently issued by the U. S. Census Bureau. The production of lumber amounted to 40,256,154,000 ft., having a value of \$666,641,367 at the place of production. In addition there were produced 3,663,602,000 lath, having a value of \$10,342,705, and 11,824,475,000 shingles, having a value of \$30,111,337, which bring the total reported value of the lumber, lath, and shingle production in 1907 up to \$707,095,409. Reports were received from 28,850 mills.

Method of Constructing a Road Through Swampy Land.

The road to be described in this note was constructed during the winter of 1906-07 by the commissioners of Union County, Illinois. The road was $\frac{7}{8}$ mile long and was built through bottom land and swamps. In the previous August the road was graded up about $2\frac{1}{2}$ to 3 ft. above the level of the ground. Before the stone arrived for the work, high water covered the road bed so that it was impossible to travel over it. In places, however, where the water was low enough, efforts were made to get the grade to specifications. It was found, however, that the grade could not be kept in shape, and accordingly work was commenced hauling stone from the ear and building on the end next to the switch. One load of stone was placed in the center of the dump and was not spread any for the final course. The final course was dumped out in the mud about 200 yds., and the road builders dropped back and commenced with the second course dumping it in the center as before. When the teams running over it did not fill the ruts, a man was employed to spread the stone and keep the ruts about level. The weight of the wagons caused the wheels to press out the side of the embankment and made a protection of earth to keep the stone from spreading and rolling too far. In this way the builders made most of the road about 8 ft. wide and about 8 ins. deep, except about 150 ft. that was water and mud that could not be drained. On this they experimented by hauling boulders from the size of 24 ins. in diameter to as large as they could handle and placed them to make a firm foundation; then put stone on top of them, which made a good road. For a short distance they put stone in the mud and water, a yard in a place to cover 8 ft. wide and 10 ft. long; then covered the stone with sand and put more stone, then sand, then stone, which cemented the stone and made a good road. In the worst place, they put in about 1 ft. of wheat straw, then put on sand to weigh it down; then put on the 8 ins. of stone. This appears to be the best part of any of the work so far as it has been tested. This road has been finished more than nine months and has been covered with water several times since being completed, and stands just as it was finished. The work was described in the recent report of the Illinois Highway Commission from which the above note has been taken.

San Francisco press reports state that the Southern Pacific Ry. is to electrify all its lines about the bay of San Francisco.

The city authorities of Galveston and the railroad companies have reached an agreement for building a 10,280 ft. long causeway across Galveston Bay. The structure will cost \$1,400,000, and concrete will be largely used in its construction.

Water-works and Sewer Section

Note: This section is devoted to methods and costs of constructing sewers and water-works. It will cover the construction work for all details of water supply and sewerage, including sewage purification and water filtration.

Method of Building a Storm Water Sewer in New York with Some Costs.

In the Borough of the Bronx, under one contract there is being built 7,159 lin. ft. of sewers. Of this, the main outlet, known as the Truxton St. sewer, empties into Oak Point River and is of a slightly irregular horseshoe section, 1,676 lin. ft. of it being 11 ft. wide and 7 ft. 2 in. high, and 1,025 lin. ft. being 11 ft. 6 ins. in width by 7 ft. 3 ins. in height. Into this empties the Whitlock Ave. sewer, the section being similar in shape; the size for 1,581 lin. ft.

sold by the Carson Trench Machine Co. of Boston, Mass. Each cableway has a span of 350 ft. and is operated by a double drum hoisting engine with two $8\frac{1}{4} \times 10$ in. cylinders. The towers are 30 ft. high. The cables are fastened to "dead men," made either by sinking a timber in the ground and then weighing it down, or by placing timbers across the trench and placing stones on them.

These cableways have proved very efficient for trench work, especially where the trench is not extremely wide. The spoil is handled from the trench and dumped either into wagons or cars, to be hauled

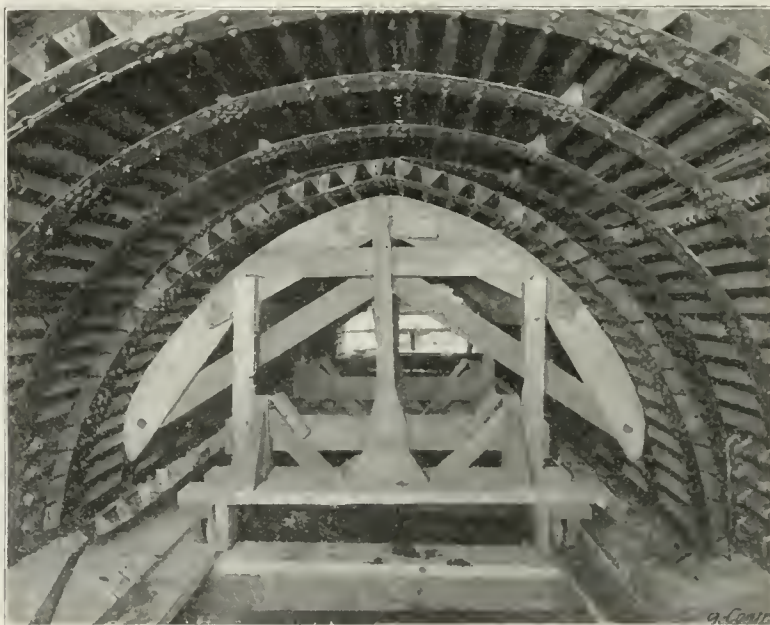


Fig. 1—Duralite Forms and Method of Moving Them.

is 6 ft. 6 in. high and 6 ft. 3 ins. wide, and the remaining 2,871 lin. ft. has a width of 6 ft. and a height of 5 ft. 7 ins.

Part of the Whitlock Avenue sewer, the work which will first be described, is 10 to 20 ft. below the surface, and the material excavated consists of gneiss rock and earth, the latter overlaying the rock in thicknesses of from 5 to 10 ft. On this section of the sewer the excavation is being done by hand, the material being handled with dump buckets by cableways and derricks.

The drilling of the rock is done with Ingersoll-Rand steam drills. When the blast are made, logs are used to prevent the rock from flying. Mats are not used as the trench is not close to any improved property.

Two cableways are used, of the Carson-Lidger wood type; these cableways are especially designed for sewer work, and are

away or used to back fill over a completed section of the sewer.

Sheet piles, shoring, forms, concrete and other materials for the sewer proper can be handled by the cableways and moved from one place in the trench to another. All of this work cannot be done with derricks, and to take down and raise derricks in moving them, consumes as much time as it takes to move a cableway.

The cableways on this job are taken down, as a rule, in two hours, and after being hauled, are erected in six hours. Thus, to move a cableway ahead to a new section of the trench means a day's work, and it must be remembered that a section of the trench 350 ft. long is being served by the cableway, while to cover a section as long would take three or four derricks.

The two cableways are worked as tandem cableways, thus one "dead man" serves for

the two cables. Ahead of the cableway a derrick is worked, thus allowing easy comparison of these two methods of serving a trench.

The earth and rock is loaded by hand into dump buckets, and taken out of the trench by the cableways. Such a bucket is suitable for handling earth, but for rock it is not to be recommended. A cubic yard bucket is about 30 ins. deep or high. Such a height is economical for shoveling earth, but for rock it is too high, and the use of such a bucket is much more expensive than to use a derrick or cableway skip. Most skips are open at one end and large stones can be rolled directly onto the pan, while in the buckets, these stones either have to be lifted up by several men or sledged so as to be handled.

buckets for the earth and skips and chains for the rock. The objection to the skips for earth is that where the earth is wet, it moves out of the open end of the skip.

The sewers are being built of concrete. Every 12 ft., on each side of the sewer, terra cotta pipes 6 in. in diameter are being placed in a concrete column in order to give connections for houses to be built in the future. Connections every 12 ft. on each side of a sewer seem to be too many, at least one of these could have been cut out by making these connections in the crown of the sewer.

When the work was commenced, wooden forms were used for the arch, the forms being built in 13 ft. sections. The concrete base was put in place, and the invert made to conform to templates spaced

rugated steel, with plates of sheet steel to go against the concrete surfaces and small strips to stiffen the forms. The forms are hinged at the crown, and do not need any braces or rods to assist in stiffening them so as to carry the load of fresh concrete.

Figure 1 also shows the method of using the forms and of moving them. The top form shown is in place receiving concrete, while one of the back forms is being moved ahead to be set. The lower section of the form is turned up on its hinges, thus clearing the bottom of the sewer. These forms are in 8 ft. sections, and a section can be moved in five minutes. With these forms, the metal gives the concrete a superior finish and allows the concrete work to be carried on in smaller sections;

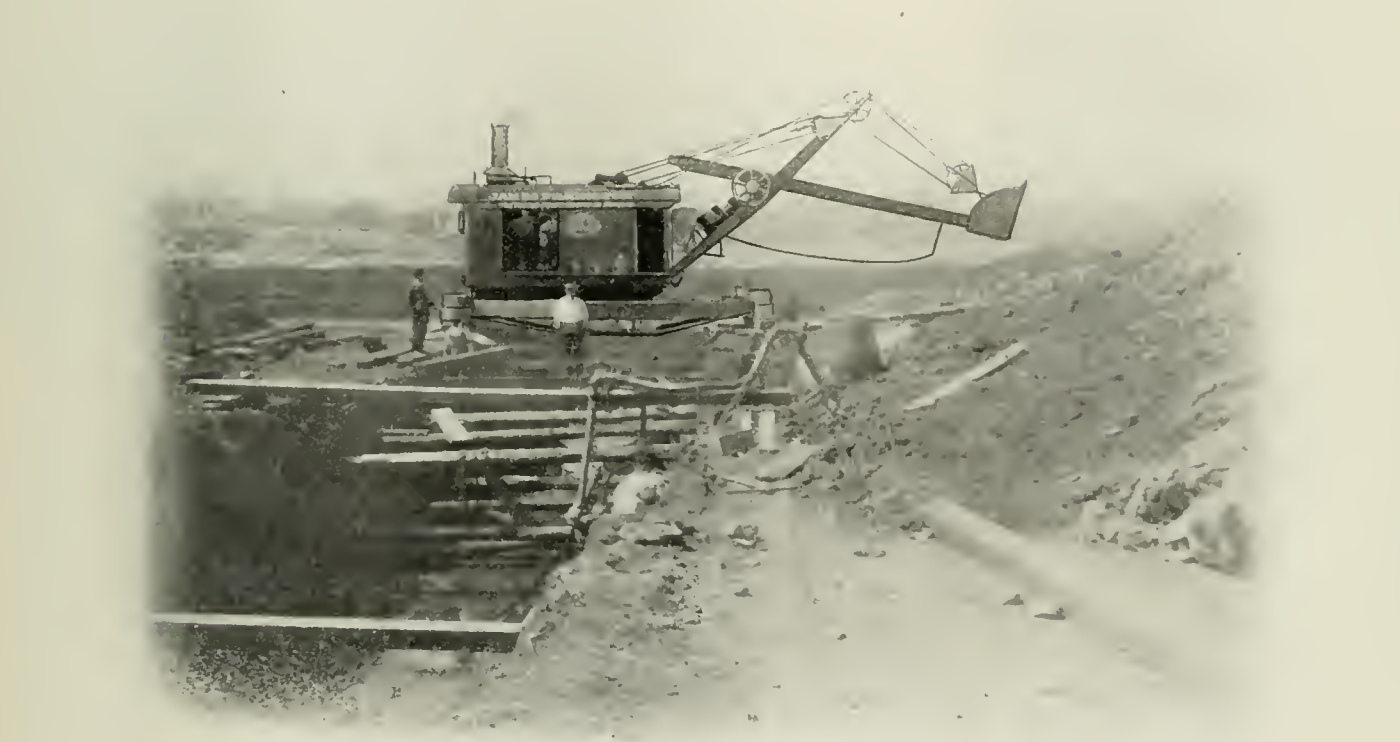


Fig. 2—Trenching with Steam Shovel in Construction of a Storm Sewer, New York.

A striking contrast of the work that a man will do loading rock into a car or bucket thirty or more inches high, and simply casting one man stone is given in "Gillette's Rock Excavation, Methods and Cost," page 161, where it is stated that a man can pick up and cast one man stone into a jaw crusher at the rate of 34 cu. yds. of loose stone for 10-hour shift, which is equivalent to about 20 cu. yds. of solid rock. On the other hand, on the Chicago drainage canal, men averaged 7 cu. yds. of solid rock, per 10 hours, loaded into dump cars. Many of the largest stones could be handled much cheaper with chains and grabs than either with dump buckets or skips.

It would pay a contractor who has both earth and rock to handle, to use the dump

at frequent intervals. Twisted bars are used for reinforcement. All the bars are cut to length and bent to the desired shape in a shop. When the invert is set, the arch forms are placed, and the rest of the concreting is done. With the wooden forms or centers, long sections of the sewer had to be done at one time, as the forms had to remain in place until the last concrete that was put in the sewer had set. This was necessary, as the last form used was the first one to be moved, and the first form used was the last one to be moved.

Many of these difficulties have been done away with, and both money and time saved by the use of Duralite steel forms. These forms are shown in Fig. 1. It will be noticed that they are constructed of cor-

and, if the invert is put in place promptly, almost daily work can be done on the arch. After these forms are set in place wedges at the bottom hold them. These forms are made of sectional pieces that are shipped to the job flat, and are assembled, when needed for use. The Duralite form is rented by the Duralite Co., of 12 Broadway, N. Y.

The concrete is mixed in a Foote mixer, the mixing plant being located under a bridge crossing the line of the sewer. Stone, sand and cement are delivered by wagons on the bridge into bins above the mixer, feeding directly into the machine. The mixer discharges into a small 1 cu. yd. dump car, and, by means of a horse and a narrow gage railroad laid along the trench

the concrete is delivered to every part of the work. From the cars it is dumped on to platforms and then shoveled into troughs, which chute it into the trench into piles, from which it is shoveled into place.

On the other section of the smaller sewer the first excavation for the trench is being done with a steam shovel. This is a No. 2 Giant, revolving trench shovel, with a long dipper arm and a dipper of 1 cu. yd. capacity, made by the Vulcan Steam Shovel Co., of Toledo, Ohio. This shovel differs somewhat in style from other shovels that have been used for trench digging. It is mounted on a truss that spans the trench, the truss being moved forward on rollers, the shovel furnishing the power to pull itself ahead by means of a steel rope and "deadman" sunk in the ground ahead. The fact that the body of the shovel revolves is a distinct advantage over revolving only the boom, as the earth is dumped farther from the trench, thus clearing it by 6 ft. or more, and not only preventing material from falling back into the trench, but also giving room for other work to be done. This is shown well in the cut, Fig. 2. The shovel setting on the truss, clears the trench well, and so distributes the weight of the shovel as not to cave in the sides of the trench except in very soft ground. This permits sheeting and bracing to be done behind the shovel, in no way interfering with the rapid excavation. Sheeting can also be done under the shovel.

The shovel has no A-frame, but the boom is held by cables that run into the body of the car, through the roof, to two drums, thus allowing the boom to be raised and lowered, which is an added advantage in trench excavation. There are crowding engines on the boom, thus holding the dipper well to its work, a very necessary feature where the digging is hard. The dipper arm is made 20 to 30 ft. long, and will dig to a depth of 18 ft. It will pile earth on the side of the trench to a height of 12 ft. By using the dipper as a ram, the top of the pile of earth can always be knocked off, the material rolling away from the trench, and additional material can be placed on top of the pile. A trench from 3 to 18 ft. wide can be dug with this machine.

The dipper is a special type for trench work, having a deep lip, beside 5 dipper teeth. The shovel has two steel water tanks, each holding 200 gals. The car body is shorter than most 35 ton shovels. The machinery, beside being very compact, is built very strong. Inasmuch as the shovel revolves through a complete circle, material can not only be placed on either side of the trench, but also can be used for back filling the trench below the shovel. When it is not desired to backfill the trench at once, it can be done with the shovel in another operation by putting a short dipper arm on the shovel. The shovel can also be used to handle pipe and other heavy materials, as if it were a derrick.

The shovel, working at its usual speed

and digging to a depth of 14 ft., will make a dip every 25 seconds, thus making more than two dips per minute. This is rapid operating when it is remembered that the dipper arm cannot be let down as the shovel is revolving, but the shovel must first be turned until the boom is over the trench and then the dipper lowered.

The shovel in question is operated by a crew of a shovel runner, cranesman, fireman and 4 ground men. A smaller crew than this could be used, but more efficient work is done with such a crew, and it is generally poor economy to attempt to save money by having a small crew in steam shovel work, except where the amount of excavation to be done daily is limited.

This shovel is working in a hard clay with a good many boulders in it, the boulders generally being smaller than $\frac{1}{4}$ cu. yd. A fair day's work in this material is about 300 cu. yds., working only 8 hours. The shovel on a number of occasions has dug 250 cu. yds. in 4 hrs., which is at the rate of 500 cu. yds. per 8-hour day. The cost of running the shovel a day with wages paid in New York city is as follows:

Shovel runner, at \$175 per month.....	\$ 6.65
Cranesman, at \$140 per month.....	5.40
Fireman, at \$60 per month.....	2.30
4 laborers, at \$2.25 per day.....	10.00
1,800 lbs. of coal, at \$3.50.....	3.15
Oil and waste.....	.50
Interest, depreciation and repairs (estimated)	6.00
Total	\$34.00

It will be noticed that the wages paid to shovel men are higher in New York city than in almost any other section of the country. The cost of the plant is about \$5,000, and the estimated item of interest, depreciation and repairs based on 200 working days per year, with an annual allowance of 24 per cent. With an output of 300 cu. yds. per day the cost per cu. yd. is as follows:

Shovel runner	\$0.022
Cranesman	0.018
Fireman	0.008
Laborers	0.033
Coal	0.010
Oil and waste	0.002
Plant	0.020
Total	\$0.113

For deep trench excavation this is a very low cost, and in other places than New York City 2 or 3 cts. per cu. yd. could be saved on this cost.

This machine has lately been moved over the streets, a distance of about $\frac{1}{2}$ a mile. The time consumed was three days, the cost of moving being:

Shovel runner	\$ 19.95
Cranesman	16.20
Fireman	6.90
4 laborers	30.00
6 extra men	36.00
2,700 lbs. of coal	5.22
Oil and waste	0.50
Total	\$114.77

This means a cost of about \$230 per mile moved. In moving the shovel long distances, it can be taken off its truss work and mounted on heavy, wide tread traction wheels, whereby the cost of moving is materially reduced.

The excavation for the large sewer, except at one place where rock was encountered, has been made by a moving derrick and a Hayward orange peel bucket of 1 cu. yd. capacity. The derrick sits on one side of the trench and is moved along on rollers. The excavated material is placed on the same side of the trench. An engineer and a helper on the ground are the entire crew needed to operate this plant. Including one move per day, the machine excavates about 500 cu. yds. per 8 hr. day. With the engineer's wages at \$1 per day, and the helper's at \$2.50, the labor cost per cubic yard of excavating the soft ground is 1.3 cts. To this should be added about 0.6 ct. as plant charges, making the cost about 2 cts. per cu. yd.

The rock excavation was made by hand, and, in order to use up this rock, a Champion jaw crusher has been installed and the stone thus crushed is being used in connection with other stone, that is bought, for the concrete work. A small belt conveyor is used on the crusher to bring the large stone back from the screen to the hopper, from which the crusher is fed. This belt is a 9 in. canvas belt, coated with rubber, and has been in use on this job and others for 2 years. The rubber is pretty well worn off the belt, but it is still giving satisfactory service.

Behind the orange peel excavation derrick, a traveling derrick, running on a skidway, is being used to put the sheeting in place. The derrick, which is mounted in the center of the platform, places the waling pieces and the heavy props, and also sets up the sheet piles. In the front, on each side of this moving platform, are two small sets of leads, spaced on the machine to the exact width of the trench. Each set of leads has a small drop hammer, and by this means, the sheet piles are driven to the proper depth. An auxiliary hoisting engine runs these small pile drivers, one driver operating at a time. The wire ropes being attached to the hoisting engine by means of a shackle, whenever desired.

Another gang of men with a derrick follow this crew, clearing up the bottom of the trench.

The ground on which the sewer is being built was originally a tidewater marsh, hence the bottom of this excavation is wet. The trench is kept free of water by means of several centrifugal pumps. On account of the soft nature of the ground the round piles have to be driven to support the sewer. These piles are spaced on 2-ft. centers. The pile driving work is being done as a sub-contract by the Tompkins Engineering-Construction Co.

The driver used is of special design, and is exceedingly well adapted to the work. It

was designed by Mr. E. De V. Tompkins, president of the contracting company, who has applied for patents on its main features. Figures 3 and 4 show the machine. It will be noticed that the pile driver sets on a truss spanning the trench, this truss moving forward on a rail laid on a stringer on either side of the trench. Rails are also



Fig. 3—Driving a Batter Pile.

laid on top of the truss, and the pile driver moves on these rails by means of wheels attached to the gunwales, from one side of the trench to the other. This allows any part of the trench to be quickly covered.

The top of the driver is on a roller, acting as a rocker, thus allowing the leads, which are hung from the top to swing like a pendulum, from side to side. Near the base of the driver, in front, is a steel I-beam shaped as a moon beam, and the bottom of the leads are fastened to this by pins, thus holding the leads to any position to which they are set. When plumb piles are to be driven the top of the machine is blocked on both sides at the rocker, thus holding it in a vertical position.

In Fig. 3, the machine is shown driving a batter pile. It will be noticed that, in addition to the set of timber leads, there is a set of steel leads that can be dropped below the machine, thus allowing piles to be driven 20 to 30 ft. below the bed of the machine. A 4,000-lb. steam hammer is used on the machine.

The work of driving piles on a sewer job is generally slow, as there is, as a rule, a lack of room. Frequently braces across the trench are in the way and must be moved. There is frequent moving of the machine, and the piles when in place are much below the level of the driver. In spite of these facts, as many as 110 piles 15 ft. long, have been driven by this ma-

chine in an 8-hour day. The piles being driven are from 15 to 40 ft. long.

All materials for the concrete came by barges to the dock at the foot of Truxton street. A track is laid the entire length of the sewer from this dock, and a Vulcan "dinkey", with some flat and some dump cars is used to haul these materials to where they are wanted. This train delivers materials to a raised platform, where it is dumped into wagons to be hauled to the concrete mixer being used on the smaller sewers. The concrete for the outfall sewer is mixed with a Diamond mixer, which is a large cube revolving on a shaft. This mixer is mounted on a moving platform that slides along on rails laid alongside of the trench. On this platform is a hoisting engine and derrick, which is used to raise the sand, stone and cement, served by the train in wooden dumps, to the bins built over the mixer. The hoisting engine likewise moves the platform along the work. As the concrete is mixed, it is discharged into a chute, dropping into the trench, where it is put into place. The cement used in the Giant Portland cement manufactured by the American Portland Cement Co. of Philadelphia.

Wooden forms were originally used for this sewer, but at present the Duralite forms are also being used, with the result that greater progress is being made with the work. But for the fact that two different sizes of sewers are being built at the



Fig. 4—Rear View of Driver.

same time, the same Duralite forms could have been used on all the sewers, by first using them for the smaller sewers and then adding additional units to them, the circumferential width being regulated by wooden strips on the bottom edge of the lowest pieces. The forms shown in Fig. 1 are made of 16 gage steel with 3-in corrugations. On this work the forms are left

in place two days after the concrete is placed. The daily rate of progress is 24 ft. per day, hence three sets of three 8-ft. sections are needed to maintain this rate of progress.

Methods and Some Costs of Driving Stove Pipe Wells on Long Island.*

BY WALTER E. SPEAR.†

To investigate the water-bearing gravels and learn something of the deep strata beyond the reach of ordinary methods of boring, the Board of Water Supply purchased and assembled at Babylon, L. I., in the winter of 1906-7, a large rig for sinking the California stovepipe well.

The substrata in Suffolk County, Long Island, to a depth of 600 to 1,200 ft. or more, is made up of unconsolidated sands and gravels, interbedded with irregular lenticular masses of clay. The clay strata are not continuous, and the ground water penetrates to great depths in the pervious sands and gravels.

The stove-pipe well and the peculiar rig for driving it adopted in southern California was first designed to meet the conditions existing in and about Los Angeles, where ancient valleys have been filled to great depths with beds of sand, gravel, clay and large boulders.

According to the testimony of the drillers in Los Angeles, the standard oil rig and casing designed for drilling in the consolidated formations of Pennsylvania, which were brought to the coast when oil was first found there, proved a failure and were given up for the stove-pipe well that is to be described.

The stove-pipe well, when in place, is a double casing made up of joints 2 ft. in length, from which the name "stove-pipe" comes. Each joint is a round cylinder of uniform diameter made of hard red steel and single riveted longitudinally with about 16 soft iron rivets. The ends of the joints are made square and smooth and butt against each other. The inner and outer tubes fit together tightly, and the butt joints of the inner line are in the center of the units that make up the outer casing, and vice versa. This gives the casing much strength and flexibility, and the construction permits the well to be rapidly assembled in the field. The first 17 to 21 ft. of well is made up in advance, well riveted together and fitted with a forged steel cutting shoe at the bottom. This rigid starter is essential in order that the well will go vertically when being driven.

A distinct advance was made in the stove-pipe casing during the past year by the Board of Water Supply. A lot of electrically welded casing was made up by a firm in Pennsylvania that proved better in every way than the riveted casing. The

*Abstracted from a paper delivered before the Municipal Engineers of New York.
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welding is all done mechanically and gives more uniform fits and a much stronger casing than the riveted material. The welded casing also makes a tight well, which is a great advantage in oil-well practice and in water-supply work.

The casing is forced into the ground by means of one or two pairs of hydraulic jacks set up about the well and attached to a plank and timber platform buried at a depth of about 10 ft. The jacks are specially made for the work and have large links that fit over lugs on the drive-head that sets on the top of the casing. The material is removed from within the casing as it advances, by a large sand bucket, or "mud scow," as it is sometimes called, which is operated from a walking-beam rig peculiar to California and the southwest.

The rig used in California for deep work is 50 ft. in height. The rig constructed by the Board of Water Supply is only 36 ft. high. This rig, like that in California, has at the top of the gins a heavy walking-beam by which the sand bucket, attached through standard link jars to a cable passing to the drum of the machine, is churned up and down by the motion given the walking-beam by the pitman and the crank on the operating gears below. By adjusting the length of the crank, a stroke of 14 to 20 in. is given the bucket, according to the character of the material encountered. The walking-beam gives the bucket a sharp, free drop that seems to be necessary for the proper operation of the bucket.

The sand bucket itself differs in nothing except in size and weight from those ordinarily used in the East. It weighs about 1,200 lbs. and is equally effective in breaking up and removing boulders and in taking out loose sand and clay. As the well descends the bucket fills, it can be lowered by means of friction feed operated by the lever at the front of the machine. This is much less delicate than the screw feed of a standard rig, but permits of rapid work in loose, unconsolidated formations.

The rig is compact, the pump, engine, and sometimes the boiler being carried on the bed of the machine; the ladder may be removed and the gins folded back when moving the rig. Three men are ordinarily required for the operation: the foreman, who stands at the front of the machine where the pressure pump, the engine, the clutches and the friction feed are operated; a helper to handle the sand bucket when it is emptied, and a fireman who tends the boiler and looks after the engine. Much skill is required by the foreman operating one of these rigs, which is only to be gained by long experience. The foreman who always holds his hand on the cable when drilling, must know when the bucket is digging, when it is full, and how far the bottom of the bucket is below the casing, in order not to come to grief.

In driving a well, the anchorage pit is first dug, the platform and jacks set in place and the first section of the well, the

starter, is set up vertically in the center. The rig has already been erected to facilitate the placing of the jacks and starter, and the driving is begun. Some difficulty is generally met, when the upper strata are coarse, in getting the starter down. The sand bucket will only work to advantage when it is covered by sufficient water to give the necessary circulation through the valve. It is essential, therefore, to keep the starter full of water, which is not always easy to do when it is some distance above the water-table, in coarse sand and gravel.

After the starter has been pushed down to the level of the top of the jacks, the drive-head is attached to the top of the bucket and lifted from the casing. One inner and one outer joint of the casing are placed one after the other, and seated by means of the jacks. When these two joints are in place, the outer shell is locked to the inner one by denting the casing with a sharp pick, and when the whole casing is driven approximately 2 ft., another pair of joints are seated and the work proceeds. In this way the well is driven as far as desired. Large wells in southern California have been driven to depths of 1,200 ft. with a single line of casing.

Stove-pipe wells, from 12 to 16 in. in diameter have been driven on Long Island. For these sizes, sand buckets with a 10 and 12-in. barrel have been used. The valves of these buckets are tight and the material is brought up from the bottom just as it lies without the separation of the coarse and the fine that occurs in wash boring. The very best knowledge of the water-bearing strata is therefore gained, and any stratum that promises well can be drawn upon.

Two types of perforators are used to admit the water to the well: one a knife perforator, which is operated with the hydraulic jacks on a line of 3-in. extra heavy pipe, and which makes slits 8 in. to 1 ft. in length, and $\frac{5}{8}$ to 1 in. in width; another, known as the "Star" perforator, is used where the material is not sufficiently coarse to permit the use of the larger knife. This is similarly operated, and makes a line of small slits, 3 in. in length and $\frac{1}{8}$ to $\frac{1}{4}$ in. in width wherever desired. The knives of both perforators are thrown in or out by means of a trip line of $\frac{3}{4}$ -in. pipe operated by block and tackle at the surface. Four of the larger perforations can be made in one diameter, although it is customary to stagger them somewhat to avoid spreading the pipe. The smaller slits can be made about 3 or 4 in. apart in the diameter of the casing.

After the perforations are made it is customary to remove the larger gravel that has come in through the perforations by means of the sand bucket, after which the well is pumped deeply to remove the fine sand that may be in the gravel about the casing, and thus complete the natural filter around the pipe. It is possible to perforate the casing where there is only a very

small percentage of gravel, sometimes not much over 2 or 3 per cent of the whole mass. When coarse material does not exist in the upper 30 or 40 ft., gravel can sometimes be dumped around the casing at the top and allowed to find its way down to the perforations as the sand is pumped out.

Eight wells, aggregating about 3,800 ft. of casing, have been driven in Suffolk county. One well, 14 in. in diameter, near Babylon, penetrated to a depth of 812 ft., and another, 12 in. in diameter, in the vicinity of Brookhaven, on which we are now working, has been driven to a depth of something over 900 ft., with one line of casing. An average progress of 30 ft. a day has been attained on this well, including time lost on repairs to rig and pump.

The cost of the casing delivered on the ground in Suffolk county has averaged about \$2.25 per foot of completed well, ranging according to size, from \$1.50 to \$2.50. The driving of the wells has cost about \$1 a foot, including the cost of moving and setting up the rig. The cost of moving has been large, and much of the work has been deep. Wells of moderate depth should be driven for \$2.50 to \$3 per foot if they are within easy moving distance of each other. You will see that the total cost of these wells will range from \$5 to \$6 per foot, which is comparatively cheap for their size and depth.

It is not unusual, in southern California, to obtain from one to three million gallons or more per day from each well. The pumping experiments that we have made near Babylon showed that a 16-in. well readily yielded 1,250,000 gal. per day, with only a moderate lowering of the ground-water surface. By pumping deeper, 2,000,000 gal. per day was obtained for a short time.

The stove-pipe well has been proven to be admirably suited to the conditions existing on Long Island. It is comparatively inexpensive, provides large yields, and should come into general use in the east, where unconsolidated strata of sand and gravel exist. Much interest has been displayed in stove-pipe wells by engineers and contractors in this vicinity, and I anticipate that this method of sinking casing will come into use for many purposes.

Ladder dredge No. 1 of the Atlantic dredging fleet of the Isthmian Canal excavated 168,796 cu. yds. of material during the month of October. The best previous record for ladder dredges was made in March by the Gopher of the Pacific dredging fleet, which took out 168,375 cu. yds. Ladder Dredge No. 1 was working during October in the channel in Limon Bay and the material handled was a mixture of mud and rock.

The excavation during October in the Central Division of the Isthmian Canal, which includes the Culebra Cut, amounted to 1,598,981 cu. yds.

Bridges, Buildings and Foundations

Note: This section is devoted to methods and costs of constructing steel and masonry bridges and buildings and of foundation work of all kinds. It will give special attention to erection plant and tools, falseworks and centers and cost data of all kinds.

The Weights and Costs of Eight Lift Bridges.

In our issues of Sept. 2 and 23 and Nov. 1, the weights and costs of bridges, other than lift bridges, have been given.

The following data will serve as a guide in making preliminary estimates of the cost of lift bridges, or bascule bridges as they are frequently called:

Cost of a Scherzer Highway Bridge.—A Scherzer rolling lift highway bridge was built in 1897 across the Chicago River at Halsted street. Length of movable part, 176 ft., divided into two leaves 38 ft. long, giving a clear span of 121 ft. between faces of abutments and 109 ft. between protection piles; length of each of the two anchor spans, 50 ft.; total length 276 ft.; width of carriageway, 34 ft. c. to c. of trusses; width of each sidewalk, 7¼ ft. center of truss to center of hand rail; total width, 50 ft. The bridge was designed to carry 100 lbs. per sq. ft., or an 18-ton motor car followed by trailers weighing 15 tons, each on an 8 ft. wheel base and having 37 ft. length. The weight of superstructure, including the 50 ft. approach spans, is 820 tons, of which 300 tons is counterweights. The weight of the machinery is 70 tons. Each leaf is operated by a 50 H.P. motor. It requires an average of 40 H.P. to open each leaf, and about the same for closing, the time required being ¾ min. to open and the same to close. The cost of the bridge to the city was:

Substructure	\$31,500
Superstructure	55,400
Machinery	13,500
Electrical equipment	5,400
Engineering, inspection, temporary foot bridge and incidentals.....	14,740
Total	\$123,600

Cost of a Scherzer Highway Bridge.—In 1894 a Scherzer rolling lift highway bridge was built across the Chicago River, on Van Buren street, Chicago. The span is 115 ft. c. to c. of bearings, giving a clear channel of 109 ft. It has 2 roadways of 21 ft. c. to c. of trusses, and 2 sidewalks of 8½ ft. each. The piers are of concrete and sandstone masonry resting on piles. Each leaf of the bridge has 3 trusses, and is counterweighted with 129 tons of cast iron. The floor is plank, resting on steel I-beams. Two 50 H.P. motors operate each leaf. Tests have shown that it requires an average of 60 H.P. to raise one leaf at a time, and 96 H.P. to raise both sides simultaneously.

Exclusive of engineering and inspection, the bridge cost:

Superstructure	\$73,100
Substructure	79,600
Electric equipment and mchly.....	11,150
Total	\$163,850

Weight of a Scherzer Railway Bridge.—A double track bascule bridge of the Scherzer type was built in 1904 to replace a draw bridge built 17 years previously, the draw bridge having become too light for the traffic on the Central R. R. of New Jersey. The bridge is part of the Newark Bay crossing. The bridge consists of two lift spans, back to back, across two separate channels. Each of these spans is 120 ft. c. to c. to center of piers, or 110 ft. between piers; but, due to the skew, the clear channel width is only 85 ft. Each span weighs 2,000,000 lbs. about half of which is in the cast iron counterweight, leaving 1,000,000 in the span alone.

Weight of a Scherzer Railway Bridge.—A rolling lift bridge of the Scherzer type was built in 1899, at the Fort Point Channel, Boston, for the New York, New Haven and Hartford Railroad. It is a skew bridge, the skew being 42°. One truss is 113 ft. long, the other being 84 ft., and the distance from center to center of chords is 27 ft. The weight of this double track bascule bridge is 381,200 lbs. The counterweights weigh 3,100 lbs. The time to operate the bridge one way is 35 secs. with a 60 H.P. motor.

Cost of a Page Highway Bridge.—A trunion bascule highway bridge was built in 1901 across the Chicago River at Ashland avenue. The bridge is of the Page type and consists of two leaves, 168 ft. c. to c. of trunions. The bridge is 258 ft. long, and has a clear waterway of 140 ft. between fender piles. The trusses are 40 ft. c. to c., carrying a 36-ft. clear roadway with two 8-ft. cantilever sidewalks, making a total of 52 ft. of floor width. The bridge is designed for a live load of 100 lbs. per sq. ft. for the roadway and 80 lbs. for the sidewalks; concentrated load 20 tons on two axles 12 ft. c. to c. The weight of steel in each leaf is 310,000 lbs. There is about 620,000 lbs of cast iron for counterweights of each leaf. The substructure required the following quantities:

Excavation	6,500 cu. yds.
Concrete	2,820 cu. yds.
Sheet piling and bracing.....	250,000 ft. B. M.
Timber in protection work and dock	23,500 ft. B. M.

Piles in protection work

and dock	7,300 lin. ft.
Piles in coffer dam	2,100 lin. ft.

The contract price was:

Substructure	\$35,540
Superstructure	91,200
Total	\$126,740

Cost of a Page Railway Bridge.—A double track single-leaf bascule bridge of the Page type was built in 1907 over the Chicago River by the Chicago & Alton Ry. It has a span of 150 ft., and there is an approach span of 64 ft. The superstructure, including electrical equipment for operation, cost \$115,000. The substructure, including the removal of an old pivot pier and some dredging of the channel, cost \$50,000, making a total cost of \$165,000. The substructure contained 3,200 cu. yds. of concrete.

Cost of a Trunion Bascule Bridge.—A trunion bascule highway bridge was built at Clybourn Place, Chicago, in 1902, according to designs of John Ericson, City Engineer. The bridge is a fixed center, double leaf, counterbalanced bascule, 128 ft. c. to c. of pivot bearings, and 120 ft. c. to c. of piers, with a clear channel of 100 ft. between the guard piles that protect the piers. The length over all is 180 ft. Each leaf has three through trusses, 21 ft. c. to c., and the total width of the bridge is 60 ft., the sidewalks being carried on 9-ft. cantilever brackets. The motive power is two 38 H.P. motors. The bed of the river is about 40 ft. below the lower chord of the bridge, and the water is 23 ft. deep. The substructure is of concrete resting on piles. The contract price was \$69,000 for substructure and \$86,000 for superstructure, or a total of \$155,000. The weight of each leaf is 640,000 lbs., including structural steel, cast iron rack, timber and counterweights. This is equivalent to nearly \$1,300 per lin. ft. of span between piers, or \$860 per lin. ft. of total length.

Cost of a Trunion Bascule Bridge.—A trunion bascule highway bridge was built in 1903 at Northwestern avenue, Chicago. It consists of two leaves, and the span between centers of trunions is 205 ft., while the span between abutments is 190 ft., and the clear width of the channel is 165 ft. between the timber protection works. There are three lines of trusses 21 ft. c. to c., and 9 ft. cantilever sidewalks, making a total width of 60 ft. There are two approach spans, one of 75 ft. and one of 17 ft. The total length of the bridge is 361 ft., and it contains 2,180,000 lbs. of structural steel, 1,400,000 lbs. of counterweight pig and cast iron, and 200,000 lbs. of machinery. The substructure consists of 1,500 cu. yds. of concrete and 3,000 cu. yds. of rubble curb walls for the approaches. The contract price for the substructure was \$88,200, and \$208,500 for the superstructure, a total of \$296,700.

The Weight and Cost of the Marent Viaduct.

In 1881 a single track iron viaduct was built for the Northern Pacific Ry. across Marent Gulch to replace a timber viaduct. The profile area of this viaduct is about 95,000 sq. ft., and the length of the viaduct is 800 ft., so the average height is practically $95,000 \div 800 = 120$ ft. nearly. It has two towers, each 200 ft. high; two towers each 120 ft. high; and four short bents.

There are 4 plate girder spans at the ends, each 30 ft.; 5 truss spans, each 116 ft. long; girders 23 ft. long over each of the four towers. The foundation piers are of concrete, of which there was 544 cu. yds. in all. The viaduct contained the following amount of iron and steel:

	Lbs.
Towers and bents	872,900
Superstructure, incl. floor beams and strs.	813,650

Total, at 2.133 lbs. per lin ft.... 1,686,550

The iron work cost 3.85 cts. per lb. delivered at St. Paul, and the "traffic charges" for transporting the iron and other materials from St. Paul, at 1 ct. per ton mile, amounted to \$24,743.

The total cost was:

Foundations	\$ 21,664.59
Masonry	30,079.81
Towers	49,188.44
Superstructure	36,593.94
Floor	4,701.43
Painting	1,826.74
Permanent track	116.06
Engineering and incidentals.....	9,085.15
Permanent track	116.06

Total\$153,362.16

Traffic charges 24,743.18

Total, at \$222.63 per lin ft....\$178,105.34

It cost \$7,664 to remove the old wooden viaduct, which contained 970,000 ft. B. M., or about \$7.70 per M. for removing this timber.

Skilled labor received \$3 to \$4.50 a day. The cost of erecting and removing the temporary buildings in which the men lived was \$2,700. Depreciation on plant was estimated at \$4,500. Both these items are included above.

For comparison the following weights of a viaduct of the same average height are given by Mr. H. G. Tyrrell. The weight of a single track railway viaduct 120 ft. high, with tower bents 30 ft. c. to c., and intermediate girder spans of 60 ft. was:

	Wt. per lin. ft.
Spans	.622 lbs.
Bents	.955 lbs.
Traction bracing	.324 lbs.

Total 1.941 lbs.

Taking the cost of steel in place at $3\frac{1}{2}$

cts. per lb. for girders and 4 cts. per lb. for bents and bracing, the cost per lin. ft. is \$75 for the steel. To this must be added the cost of the concrete pedestal piers.

For a much more completely itemized record of cost of labor and materials for three viaducts, and a rational formula for estimating the weight of viaducts, the reader is referred to our issue of June 19, 1907.

Cost of the Frazer River Bridge.

The Frazer River Bridge at New Westminster, B. C., was built in 1902. It is a double deck bridge, the upper deck for wagon traffic and the lower deck for steam and electric traffic. The spans are as follows: one 225 ft., one 380 ft., and one swing span 380 ft., five spans 159 ft. each, making a total of 1,780 ft. On the north end there are three approaches, two for railway tracks and one for highway, the length of approach averaging about 300 ft. The clear roadway is 16 ft. wide, making the trusses 18 to 19 ft. c. to c. The weight of steel is 6,854,000 lbs., and there are 765,000 ft. B. M., and 15,000 lin. ft. piles in approaches. The contract price for substructure and superstructure was \$750,000.

Weight of the Burlington Bridge of the C. B. & Q.

In 1890 a double track steel railway bridge was built across the Mississippi River, at Burlington, for the C., B. & Q. R. R., to replace a single track iron bridge built 22 years before. The 6 spans of 250 ft. each, weighed 3,340 lbs. per lin. ft. The draw span of 363 ft. weighed 3,980 lbs. per lin. ft. The bridge was designed to carry a moving load of 6,000 lbs. per ft. of double track structure (3,000 lbs. per ft. of single track), this load being increased 50% in estimating the variable effect of a moving load.

The cost of engineering was 5% of the total cost of piers and superstructure.

Weight of a 533-ft. Span Railway Bridge Across the Delaware.

A double track railway bridge was built in 1896 across the Delaware River, at Bridesburg, for the Pennsylvania and N. J. R. R. Co. There are three spans of 533 ft. each, and a draw span of 323 ft. The weight of steel in each of the three 533 ft. spans is 4,182,000 lbs.

The weight of the steel in the draw span with riveted work is 1,505,000 lbs., and the weight of the machinery is 356,000 lbs., total 1,861,000 lbs.

A steel traveler was used to erect the bridge. The traveler was 110 ft. high, 46 ft. wide at the bottom and 81 ft. wide on top. Its weight was 292,000 lbs. without trucks.

The Cost of the Pecos Viaduct.

The Pecos Viaduct, Texas, was built in 1891 for the Galveston, Harrisburg & San Antonio Ry. It is a single track a steel viaduct 2,180 ft. long, and 321 ft. high at the center. The viaduct is built on a peculiar profile. For 1,070 ft. of the west end the average height of the viaduct is 57 ft., then the ground drops off precipitously, so that for a distance of 600 ft. the towers are 260 ft. high and rest on masonry piers, of varying heights up to 80 ft. Then the ground rises on an almost uniform slope to the last pier on the east end. The profile area below the base of rail, 200x200 and above the masonry piers is approximately 280,000 sq. ft. Dividing this by the length gives 129 ft. as the average height of the viaduct. None of the tower piers are under water at times of low water, but three of them are submerged at times of high water. There are 33 towers and the tower spans are plate girders 35 ft. span. The spans between the towers are 8 riveted lattice girder spans of 65 ft., 2-pin-connected cantilever spans of 172 ft., and one 80 ft. suspended span. The masonry piers were built in 229 working days. The steel work was erected in 118 days, including 24 days required to build a traveler weighing 116 tons and 6 days to take it down and move it to the opposite side of the river. The erecting gang average 60 men and at no time exceeded 79. The average amount of steel erected were 42,000 lbs. per day for the 86 days, or 39,600 lbs. per day for the 118 days. If it were \$2.50 a day, this would be equivalent to 0.36 ct. per lb., exclusive of the cost of erecting and moving the traveler, 0.5 ct. per lb. including erecting and moving the traveler. The actual wages paid are not available, but the actual cost of erecting this viaduct was 0.87 cts. per lb. including not only the cost of erecting the traveler but the cost of the traveler itself.

The weight of this viaduct was as follows:

	Lbs.
34 plate girder spans, 35 ft. long..	495,550
1 plate girder span, 35 ft. long..	24,810
8 lattice girder spans, 65 ft. long..	354,120
1 lattice girder span, 80 ft. long..	57,870
2 cantilevers, 172½ ft. long....	478,400
Floor bolts and railings.....	51,620

Total superstructure 1,462,370
Towers and anchor bolts.....2,147,190

Grand total 3,609,560

The cost was as follows:

3,270 cu. yds. masonry at \$13.....	\$ 42,505
3,609,560 lbs. steel delivered at \$4.43 cts.	160,000
Erecting, including cost of traveler	30,500
256,600 ft. B. M. timber flooring at \$20.75	5,325

Total\$238,330

This is equivalent to \$119 per lin. ft.; and the weight of steel was 1,650 lbs. per lin. ft.

Railway Section

Note: This section is devoted to methods and costs of constructing railways. It will cover road-bed and track construction, contractor's plant and organization, surveying methods and permanent way structures.

Methods and Cost of Handling of Locomotive Coal and Ashes.*

By C. F. WHITTON, S. CAN. SOC. C. E.

The endeavor of the present paper is to treat briefly on current practice and designs for coaling and ash-handling plants. In order to facilitate comparison of costs, most of the figures furnished by the railroad companies being total costs for a single year, the writer has endeavored, as far as possible, to analyze these according to information personally obtained regarding the actual working of the various stations.

The total expense for handling coal, which has been reduced to a tonnage basis, includes: (1) Fixed charges; (2) operating charges; (3) maintenance charges; (4) pro-rata charges.

The fixed charges, which comprise interest, depreciation, insurance, and taxes, have been taken as 10 per cent of the total initial cost of the plant. Maintenance and operating charges vary so widely with local and climatic conditions that, considering also the short time over which the costs obtained extend, they can hardly be considered exact, and certainly not applicable, except as an indication of general results. Pro-rata charges are estimated as follows: The proportion of time of yardmaster, clerks, etc., is distributed to the different departments on a labor output basis, and the per cent added to the cost of handling coal and ashes is the proportion of the above wages based on the ratio which the labor charges for each of these departments bears to the total labor charges of all the departments of the yard. By several railroads, this amounts to about 20 per cent of the labor charge for the coal and ash handling plants.

The chief objects aimed at in the choice and design of a type of coaling station are:

a. The minimization of delays to engines. Rapid and systematic handling, when the daily number is large, is very important. Several types of plant now in operation are designed to supply coal, water and sand simultaneously to as many as 12 locomotives. Ashes, too, are sometimes removed by the same machinery which handles the coal, though, except in the case of the locomotive crane, this plan is generally unsuccessful on account of the excessive wear and corrosion of the moving parts of the carrier. A separate plant is therefore usually installed for this purpose.

b. The minimization of handling costs. Many factors and local conditions enter into this question, among which are:

(1) The physical location of the plant with regard to coal supply.

(2) The available ground space which in some cases is limited in length by the distance between yard terminals.

(3) The possibility of future extension.

(4) The number of locomotives handled daily.

(5) The type of coal cars, i. e., whether the majority are self-clearing or require shovelling.

These factors also govern the question of the bin capacity necessary. An ample storage supply ensures against interruption of shipments or delays due to breakdowns, derailments, and plant repairs, but adds materially to the initial cost. The track arrangement also, while affording free movement, should be as compact as possible.

Handling of Ashes.—The selection of the type of ash pit practically depends on one factor, viz., the number of locomotives to be handled daily, for, whereas two minutes may suffice for the operation of taking fuel, 30 minutes to 1 hour, depending on the type of locomotive and season of the year, may be consumed in getting an engine over an ash pit.

The Locomotive Crane.—The locomotive crane system is found in certain localities to be admirably adapted to the rapid and economical coaling of locomotives, and is extensively used for the handling of ashes. Among its many advantages is its usefulness in the handling of other materials, such as sand, ore, etc., and that, when fitted with a crane-hook, it may be transported from place to place and employed as a light wrecking crane.

The crane has the functions of hoisting, rotating and traveling under its own power. One operator consists of a supporting frame and boom, drums, engines, boilers, etc., the latter rotating oppositely to and counterbalancing the loaded bucket. The truck supporting the machinery is of standard gauge, and is driven by gearing from the engines.

The grab bucket used for handling coal and ashes has the advantage of a certain excavating power when seizing the material, so that flat-bottomed cars and ash pits can be scraped almost completely clear, causing a great reduction in the cost of labor.

At coaling stations of this type, the coal is either transferred by the crane directly from cars to the engine tender, or from storage, if such be provided. This generally consists of either a ground pile, pockets, or pits.

In the first case coal is taken from the

cars by crane and piled by the side of the track within easy reach. As much as 10,000 tons can be thus held for emergency requirements.

Pocket storage is generally provided either for the purpose of weighing the amount taken by each engine or to insure extra rapid fueling. An overhead bin adjacent to the fueling tracks is subdivided into pockets of known capacity, provided with sloping bottoms, gates, or chutes. These are filled and kept so by the crane during slack hours either from pile storage or from cars.

Pit storage is also sometimes provided beneath the tracks, where a large number of self-clearing cars is available. The crane transfers coal direct from these pits to tender.

At the Cleveland yards of the Erie R. R. the crane takes coal from the cars on a side track and delivers it to the tender while the ashes are being removed from the engines.

For this purpose there is provided beneath the locomotive track a concrete pit sloping outwards, so that the ashes will fall into the clear space at the side, from which they are lifted and dumped into cars by the crane.

The crane makes over 50 trips per hour, and operates a 2-ton grab bucket. Such a coaling station requires only the services of one man, although two are frequently used—one to operate the crane, and the other as helper in the coal car to clear the corners and guide the baskets.

The following figures represent the coal handling capacity of this crane:

a. Average number of locomotives fueled per day.....	25
b. Average tonnage per 12 hours....	168
c. Maximum actual tonnage per 12 hours	180
d. Total tonnage for year 1906.....	60,500

The initial cost of the crane was \$7,400. and the cost of bucket, pits, etc., is estimated at \$4,600. The handling costs, per ton, are made up as follows:

Average tons handled per day.....	166
Fixed charges, per ton.....	2 cts.
Operating charges, labor.....	2 "
Operating charges, power and supplies	3.5 "
Maintenance charges	0.3 "
Pro-rata charges	0.4 "

Total cost per ton..... 8.2 cts.

(N. B.—No ash handling costs were available for this plant.)

Other locomotive crane plants show the costs given in Table I.

It is well perhaps, to call attention to the fact that, in the above cases, the cost of handling ashes does not include any proportion of the fixed charges.

The actual cost per ton is not so important as a comparison of costs between old and new methods of doing the work. In the case of the Erie plant, at Cleveland, the reduction per ton due to the installa-

*A paper read before the Canadian Society of Civil Engineers, March 19, 1908.

tion of a locomotive crane was about 12 cents. At this plant there is another crane not in service at present.

Belt Conveyor. The inclined belt conveyor is a very well known type, an example of which is found at the Cleveland yards of the Pennsylvania Lines West. This plant consists of a single pocket of 500 tons capacity fed by a belt from a track hopper. This is situated beneath the coal car track, and directs the coal on to a steel trough of trapezoidal section, from which it is delivered to the belt by an automatic feeder making about 35 strokes per minute.

This is built of steel plates to fit the trough section, is mounted on rollers, and

compressed air (also supplied from the shops) to a steel storage tank at the top of the bin, from which it is piped to the engines as needed.

The coal pocket itself is a wooden structure 21 ft. square by 83 ft. high, with undercut gates and iron-hooded chutes feeding a through and an outside track.

To prevent trouble due to accumulation of slack, the bins are designed with hopper bottoms, and the coal is delivered from the belt by means of adjustable chutes directly to the points of supply. The slack is thus used as it is delivered, whereas a straight fall would cause the large lumps to roll to the mouths of the chutes, while the slack would collect and finally slide out

suitable machinery and dumped into a pocket or directly into an ash car on an adjoining track.

At this station there are three locomotive dumping tracks, with track hoppers, each 18 ft. long, and having a longitudinal pit extending beneath the tracks for 16 ft. on each side of the hopper, so that a locomotive headed in either direction may have the fire cleaned over the track hopper, and the flue dust dumped into tubs running in the longitudinal pit at the same time.

For quenching the ashes, water pipes perforated with small holes are laid around the sides of each hopper.

Running beneath the hoppers is a cross pit, 12 ft. deep by 6 ft. wide by 48 ft. long, in the bottom of which is a 3-ft. gauge track, on which runs a truck and detachable bottom-dump bucket of about one-quarter ton capacity.

Stationed in the pit is a man who operates the hopper gates and chutes, and moves the bucket when filled to the open end of the transverse pit. Here a hoisting cable, driven by a 15-HP. engine and winding drum, is attached by a crane hook to the bucket. It is then lifted out of the pit and, locking by means of an automatic latch with a small carriage, runs along the overhead inclined way until vertically over the adjoining ash car track.

The dumping of the ash bucket is automatic, and is best explained by describing its construction which is based on the principle of ice-tongs.

The bucket is built in two parts, and attached to the sides, near the top, are two arms which cross in the middle and hinge with a belt, to which is also fastened a ring. When in suspension, the weight of the bucket, acting as the hinge, keeps the sides closed together. When over the ash car, two projecting plates on the runway engage the arms and, by pressing them down, force apart the two halves of the bucket.

This method combines several advantageous features, simplicity, compactness, and low operating cost. The power for the hoisting machinery is supplied by a 15-HP. engine, and the whole system, outside of the actual dumping of the locomotives, can be operated by two men. The pits, while preserving a minimum area to surface drainage, are very cheap to install, the first cost being about \$5,000. During 1906 the number of locomotives handled was upwards of 18,000, and the cost per locomotive was as follows:

Fixed charges	2.4 cts.
Labor of operating plant.....	27.5 "
Cost of power and supplies.....	1.1 "
Maintenance	.2 "
Pro-rata charges	5.6 "

Total cost per locomotive cleaned, 36.8 cts.

Bucket Conveyor.—The next type of station is the combined bucket elevator and conveyor.

The Lake Shore & Michigan Southern Railway, at Elyria, Ohio, has a main line

TABLE 1.—COST OF COAL HANDLING.

Location	Buffalo.	Leipsic.	Belle-ville.	Flt. Wayne.	Con-neaut.	Stoney Island.	Cleveland.	Mina.
Year	1905	1905	1905	1905	1905	1905	1906	1906
Average tons per day.....	176	116	230	153	106	45	166	218
Fixed charges	1.9	1.7	1.8	1.8	3.7	7.9	2.	1.5
Operating charges	4.7	6.1	3.6	5.1	3.0	5.5	5.5	3.5
Maintenance charges.....	0.5	0.2	0.7	0.5	0.1	0.2	0.3	0.1
Pro-rata charges	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total charges per ton.....	7.5	8.4	6.5	7.8	7.5	14.0	8.2	5.5
ASH HANDLING.								
No. of locos. cleaned per day.....	20	13	26	17	12	5	19	25
Cost per loco. cleaned.....	4.8	..	3.8	22.4	3.3	4.7	..	..

has a reciprocating movement actuated by a crank driven from the lower belt drum shaft. At one end of its stroke it uncovers the hopper opening and pushes the coal that falls through along the trough until it falls on to the belt. The feeding action is intermittent, and is automatically regulated by the speed of the belt. Around the lower part of the belt are wooden guards to prevent the coal from spilling as it falls from the trough.

The belt is made of cotton duck faced with rubber $\frac{3}{8}$ in. thick by 30 in. wide, and runs about drums on 200-ft. centers. The slope is about 25 degrees, according to the usual practice, and it is troughed by means of 3 roll idlers, set 5 ft. 3 in. apart. The inclination of the outer rolls is about 20 degrees, and lubrication is effected by grease cups, which also help to protect the journals from grit. The belt will deliver 100 tons per hour at a speed of 200 ft. per minute, but in daily operation averages 50 tons in 12 minutes, with a speed of 125 ft. per minute, the power consumption being about 15 HP. The average life of one of these belts is from 2½ to 4 years.

The belt and its supports, together with a 2-ft. gangway, are completely housed, the housing being supported midway by a wooden trestle tower. Beneath the belt runway is the engine room containing the belt driving drums, which are geared to on 18 HP. simple horizontal engine making 110 revolutions per minute. Steam is supplied from the roundhouse boilers (a distance of about 500 ft.) by an overhead pipe protected by galvanized iron casing.

In a shed beneath the coal wharf the sand for the locomotives is screened and dried in a small oven, from which it drops through a bell hopper into an air-tight chamber. It is then shot up by means of

in large masses, interfering seriously with train performance.

All slack adhering to the descending side of the belt is removed by a rotating brush.

The original cost of this plant was \$13,000, and it is in operation for 10 hours per day.

Average number of locomotives fueled per day	50 to 75
Average tons handled per day (1906).....	230
Maximum tons handled per day on a monthly basis	570

The labor connected with this plant includes one engineer in charge of the machinery, and two laborers.

The handling costs for 1906 are made up as follows:

Average tons handled per day.....	258
Fixed charges	1.4 cts.
Operating charges	2.8 "
Maintenance charges (belt renewal) ..	0.2 "
Pro-rata charges	0.2 "

Total cost per ton..... 4.6 cts.

Ash pits are in general divided into two classes:

1. *Shovel Pits.*—These are of the ordinary open-sided type, with or without a depressed track for ash cars.

2. *Mechanically Operated Pits.*—Under this heading come:

(a) The Locomotive Crane;
 (b) The Bucket Conveyor; and
 (c) The Overhead Trolley, which also is found in several different forms. In some cases it consists of a single or several concrete pits (according to the number of cleaning tracks) spanned by an overhead trolley track. Locomotives discharge fire-box cinders and flue dust simultaneously into pit tubs, which are then elevated by

wharf of 500 tons capacity, bridging four main tracks. There are two independent bucket systems which are practically alike in all details, and will, therefore, not require separate discussion.

The wharf is a wooden structure supported on steel construction; 80 ft. long by 29 ft. wide, the upper runs being 62 ft. above the tracks.

Under each coal track at the side of the wharf is a steel hopper built in two compartments with plunger feeder under each opening, which delivers the coal at regular intervals to the carrier. The object of having two compartments and feeders is to divide the flow of coal, so that the feeders work alternately, the rate of delivery thus corresponding to the capacity of the buckets. This allows of increased speed without danger of overloading either feeder or carrier.

The feeders are, in their simplest form, steel plates, mounted on rollers, which derive a reciprocating motion from a crank connected to the foot shaft of the carrier.

From the feeders, which make 60 strokes per minute, the coal drops into the horizontal steel trough or "run," from which it is elevated by the buckets (which are enclosed in a vertical steel casing) to the upper runs. One system of this plant has a crusher interposed between the feeder and the horizontal run. There are four 125-ton pockets, and over each a discharge gate consisting of a section of the trough operated by rack and pinion from the upper platform.

The buckets of these conveyors are of the standard gravity discharge type, spaced 3 ft. apart. They are V-shaped, and are attached rigidly to a double-strand steel link chain of 12-in. pitch, with flanged rollers at the articulations of the links. The speed of the buckets is about 65 ft. per minute, and each system is designed to handle 100 tons of run of mine coal per hour.

For measuring the amount of coal delivered to each engine each bin is mounted on 105-ton capacity recording scales. After each draft the scales are balanced, and the difference of weight of the pocket is noted against the number of the engine.

The under cut gate and reverse coal spout, unlike most others, are not operated by the locomotive firemen, but are connected by a system of chain-connected levers operated by an attendant who is located in the structure at a point where he commands a view of the engines passing under the pockets. The gates and spouts are interlocking, so that a gate cannot be opened until after the spout is lowered, and the spout cannot be raised before the gate is closed.

Power is supplied to one conveyor by a 32-HP. gasoline engine making 200 revolutions per minute. For the other system power is derived from a 60-HP. gasoline engine making 160 revolutions per minute.

Rope transmission is used throughout.

The plant is operated by an engineer, a fireman, and two laborers.

The following figures represent the operation of this plant:

- a. Average number of locomotives fueled per day.....60 to 70
- b. Average daily tonnage—summer... 300
- c. Total tonnage for year 1906.....88,250

This plant, as originally installed, consisted of the main structure and one conveyor system, and cost \$31,000. Later the second conveyor was installed at an estimated cost of about \$15,000, but as one conveyor only is in continuous operation at present, the fixed charges have been estimated for the original cost of \$31,000.

Average number of tons handled per day	242
Fixed charges	3.9 cts.
Operation charges	2.8 "
Maintenance charges	2.1 "
Pro-rata charges	0.1 "

Total cost per ton..... 9.3 cts.

Trestle Plant.—An example of the trestle wharf is found at the Collinwood, Ohio, yards of the Lake Shore & Michigan Southern Railway.

This plant consists of a plain trestle (with inclined approach), provided with two one-hundred ton pockets, with two hundred tons auxiliary storage in the shape of loaded self-clearing cars on top of the trestle. It is located between two tracks, one for freight and the other for passenger locomotives.

On this trestle is also a sand bin of 30 carloads capacity, from which the sand flows into the drying house and is shot up by compressed air into an overhead tank.

The storage part of the trestle is 200 ft. long and 35 ft. above the ground level. It is approached by an inclined trestle 560 ft. long, forming a 6 per cent slope. The object of this design is to necessitate but one shift, i. e., to replace the empty cars on the trestle with loaded ones once in twenty-four hours.

The object of having two separate pockets is to provide not only sufficient trestle storage, but, as the number of locomotives handled daily to the wharf is large, to allow two locomotives on each track to be coaled simultaneously without increasing the length of the pockets. A natural mixture of the coal is maintained, as at the Cleveland belt conveyor plant, by means of adjustable chutes directing the flow to the points of discharge.

The operation of this plant is shown by the following figures:

- a. Average tons of coal handled per day—summer
- Average tons of coal handled per day—winter
- Average tons of coal handled per day—fall
- b. Total tons of coal handled during 1906
- c. Time to unload fifty ton cars by shoveling
- d. Average number of locomotives handled daily—summer

Average number of locomotives handled daily—winter..... 65

c. Average tons of coal taken per locomotive:

Yard engines 5 to 8
Freight and pass. engines...8 to 15
Average 10

The labor force consists of 3 laborers and a foreman, who also has charge of the ash-pit gang.

The original cost is estimated at \$15,000 and the handling costs for 1906 are as follows:

Tons handled per day.....	635
Fixed charges	0.7 cts
Operating charges	4.1 "
Maintenance charges	0.1 "
Pro-rata charges	0.4 "

Total cost per ton..... 5.3 cts.

The method of elevating the coal is a distinct disadvantage to the trestle system for, disregarding the expensive nature of the inclined approach, the employment of a locomotive to haul a long and heavy load of coal cars up a 6 per cent grade is a most uneconomical method. Power is wasted not only in elevating the dead weight of the cars themselves but also in their return to the ground level under the force of gravity.

The ash pits are of the ordinary open-sided type with depressed track generally installed where the ashes are handled by shoveling. There are two sets, one accommodating four freight locomotives, and the other four passenger locomotives.

The handling capacity of the pits is as follows:

Average number of locomotives having fires cleaned per day..... 58
Total number of locomotives having fires cleaned per year.....21,000

The cost of handling ashes is estimated as follows:

Fixed charge	4.8 cts.
Labor	26.1 "
Power, supplies, etc.....	1.2 "
Pro-rata charge	4.8 "

Total cost per locomotive cleaned,35.7 cts.

Vertical Lift Type.—An interesting plant of recent design and installation is that installed by the Pennsylvania Lines West at Alliance, Ohio. It is a wharf of 350 tons bin capacity, fed by two vertical cars from track hoppers. The hoppers feed alternately to each car, one of which ascends loaded as the other descends. The hopper gates and chutes are controlled by a chain drive from an operating room placed on the track level between the vertical shafts. Beneath this room are situated the cable drum and 25-HP. driving motor controlled by the operator from the room above. The hoisting cables are wound oppositely on the drum so that the weight of one car balances that of the other.

Each car holds 3 tons, and is built with a sloping bottom and a door which is automatically unlatched by a tripping device at

the head of the shaft, and swings out, chuting the coal into the bin. On starting to descend, it is automatically shut and latched.

The cars are brought to rest by brakes controlled from the operating room. The handling capacity of the buckets at a speed of 60 ft. per min. is 100 tons per hour, the total vertical lift being 83 ft. The plant is in continuous operation. The whole arrangement is very simple, and requires but one attendant and a laborer to look after the cars.

The initial cost of this wharf was \$18,000, and the average number of locomotives fueled daily is about 50, but, as the plant had only been running 6 weeks when visited, further costs were unobtainable.

From the point of view of simplicity and compactness, this type certainly possesses undoubted advantages. The labor cost is small, and the absence of complicated machinery should reduce the power and maintenance costs to a very low figure. The system is built with capacities as high as 700 tons, but where larger capacity is needed, the bucket conveyor system is substituted.

The ash handling plant installed at these yards is in every way the counterpart of the Cleveland plant except that electric power is used.

Without attempting to draw any definite conclusions, it may not be considered out of place to make a brief comparison of the relative advantages and objections of the above types of coaling station.

In the first place, the locomotive crane has offered a very successful and moderately cheap method of handling coal and ashes in locations where the demands are not excessive. Its practical limit is said to be about 70 locomotives a day, as the capacity of the bucket is necessarily below 5 tons, and the number of trips per hour is restricted to about 50.

It is not as rapid as plants having gravity discharge from storage, but, as the engine is necessarily held over the ashpit for about 40 min., this feature is hardly objectionable as delays to engines can be obviated by providing pockets.

The system proves a very flexible one on account of the diversity of arrangements possible. One disadvantage of open-air storage in pockets or pits, however, is the liability of the coal and gates to be frozen up in cold weather. With the necessary tracks, pits, and pockets, it will be found that this sort of plant has a considerable first cost. Its operating cost depends upon the work which can be provided at spare times. Its value is great in emergency situations, and at points where, because of impending changes, the construction of a permanent plant is unwise. With a large terminal where a conveyor plant is used, a locomotive crane can be very valuable to handle cinders and sand, and also coal during a possible breakdown of the conveyor. Then again not only can it unload direct from flat bottom cars, handle ashes

as well as coal, move to any spot desirable to stop the locomotive, but if superseded by a different system, can be easily moved to another point. These are a few of the points of interest concerning the locomotive crane, but within its proper sphere of capacity, it seems to prove one of the very best now in use.

The inclined belt conveyor has also several features of advantage. Besides having as low a first cost as any other handling system, the simplicity of the machinery reduces greatly the operating and maintenance expense, the latter, being mainly an allowance for belt renewal. A belt will handle large quantities of coal noiselessly and with little breakage, requires but about two-thirds the power of a chain conveyor, while practically the only attention necessary is occasional lubrication of the moving parts, and the taking up of slack. The troughing should not be so great as to cause the belt to crack, nor the coals so large as to cause the belt to run out of line and chafe at the edges.

Of course this system takes up considerable ground, but in certain locations, where plenty of space is available, a better storage yard for coal cars can be provided by this than by other types as the receiving hopper is placed at some distance from the storage bin.

The belt system, however, has not the flexibility of the chain conveyor which lends itself to the formation of many types of station, and can be adapted to almost any arrangement or local conditions. The latter takes up very little ground space, and can handle from 30 to 500 tons an hour, though it has a tendency to break up very soft coal.

Its main disadvantage is a somewhat higher initial cost than other systems, though stations with an actual daily working tonnage of about 75 tons can be built for \$16,000 or \$17,000; second, operation is inexpensive, but maintenance varies considerably, according to the care taken with the machinery. This contains many working parts and, as the strains are pretty severe, the excessive wear at the link-articulations, unless very well lubricated, will cause considerable uneven elongation to take place. This seriously affects the life and efficiency of the system, and repairs and restoration of parts may greatly increase the cost of maintenance. Many of these plants, however, are in operation at present, and, when well cared for, they give excellent service at a reasonable cost.

The trestle system, with gravity discharging pockets, and a steep or light grade approach (according as the cars are placed by yard engines, or by some other power), has, perhaps, the most widespread use of all the types of plants already described. Its advantages are cheapness and simplicity of design and operation. In location where a large number of locomotives are handled and two tracks only are to be served, it has proved very satisfactory and economical.

An item of importance not mentioned before is the necessity for fire protection. This, together with the recent and prospective increases in the price of labor and timber, have tended to increase the desire to have better plants built of steel or reinforced concrete.

Regarding the question of locomotive coaling plants in general, it seems that, for small terminals, the two bucket lift locomotive crane, or a trolley hoist, using a bucket of the clamshell type seems suitable, while for larger plants the trestle or a conveyor plant is desirable. In most cases, however, not the economy of the plant but the economy of the yard is found to be the determining factor in fixing the particular kind of plant to be used, it being necessary to use systems adapted to the space available at the terminals, regardless of small economies and differences in types.

The work of ancient Egyptian surveyors was described recently in an address delivered before the Royal Geographical Society by Capt. H. G. Lyons, director-general of the survey department of Egypt. At every period of ancient Egyptian history, he said, the land was measured and recorded with considerable accuracy; property was dealt in regularly, and an elaborate system of registration was maintained. No map of landed property in ancient Egypt has come down to us, but on the tomb walls we meet with representations of land measurers at work. Their methods of land measurement are represented on the walls of the tomb of one Menna at Sheikh Abd el Qurna, in Thebes, a land overseer and inspector of the boundary stones of Amon. In the scene depicted are shown two chainmen measuring a field of corn with a long cord, on which are knots or marks at intervals which seem to be about four or five cubits in length; each also carries a spare cord coiled upon his arm. Beside them walk three officials, who carry writing materials, and who are accompanied by a small boy carrying writing materials and a bag in which are probably documents and plans referring to the property. An old man and two boys also accompany the surveyors, and a peasant brings a loaf of bread and a bunch of green corn. A similar scene is pictured on the walls of a tomb belonging to a certain Amenhotep, also at Sheikh Abd el Qurna. Here only one man accompanies the chainmen, each of whom, as usual, carries a spare cord. The figures are larger than in the tomb of Menna, and though they are now much damaged, it is possible to see clearly that the cord terminated in a ram's head.

Up to Nov. 1, contracts of a total value of \$29,780,294 were in effect on the New York State Barge Canal work. The total value of the work done on those contracts to Nov. 1, 1908, amounts to \$7,567,303. During the month of October the total value of the work on these contracts was \$921,400.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Seepage Loss of Water from Lined and Unlined Irrigation Ditches, with Some Costs of Lining.

The lining of canals to prevent the loss of water by seepage is not usually necessary where water is plentiful, but, when water is difficult to obtain, the loss of water then becomes so important that it is necessary to line canals that are meant either for power or irrigation purposes. Measurements of loss by seepage, made on a large number of irrigation ditches in California, show an average loss on main canals of about 1 per cent for each mile that water is carried. On laterals in some cases the loss amounted to 11 and 12 per cent per mile. At times, however, the loss has exceeded 50 per cent.

In gravelly soil the loss is always excessive, and the water so lost from irrigation canals and ditches is more than wasted, as this water collects on lower lands, filling the soil and souring it, drowning the roots of trees and plants, and, when it collects in pools, furnishing a place for the breeding of mosquitoes.

In order to determine the seepage loss of water in small irrigation ditches, the following experiments were made by the Agricultural Experiment Station of the University of California under the direction of Mr. B. A. Etcheverry. The following is extracted from his report:

The purpose of these experiments was to determine the relative efficiency of canal linings, as regards seepage only, and not to compare the resistance of the lining to the cutting or erosive force of running water.

For this purpose twelve ditches closed at both ends were excavated in earth of uniform texture, that they might all be under the same conditions. These ditches were lined with the different materials used in California for the lining of irrigating canals. After the ditches were excavated and lined daily measurements were taken to determine the rate of seepage, and from these the relative efficiency was obtained.

The site chosen for the experiments is in Stanislaus County, near Modesto, on the University experimental farm, about $3\frac{3}{4}$ miles east of the town. Lateral No. 1 of the Modesto Irrigation District ran near the south end of the ditches and was the source of water supply for the experiments.

The soil is a fine sandy loam and is very homogeneous to a depth of 2 ft.; below this some hardpan was found in the north end of the ditches. This hardpan only occurred in small quantities and was in a soft

condition. It could be plowed and removed with scrapers. It is to be regretted that a site with a more sandy soil was not available, as the results might have been more conclusive.

The ditches were parallel and ran north and south, at right angles to Lateral No. 1 (Fig. 1.) The south ends of the ditches were at approximately the same distance from this lateral, so that the seepage from it, if any, would affect each ditch equally.

A wooden flume built with 1-in. by 12-in. redwood lumber, running parallel to the lateral and along the south end of the ditches, carried the water from the lateral to the ditches; a gate in the flume was provided for each ditch.

The ditches were at the same elevation, that the effect of underground water might be equal, and were all $2\frac{1}{2}$ ft. deep, with

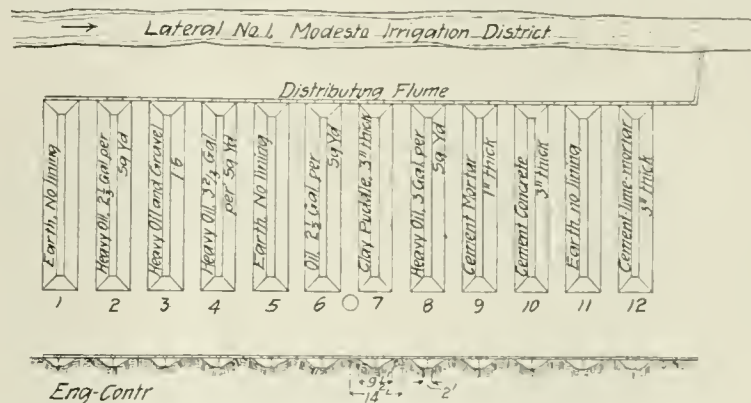


Fig. 1—Layout of Irrigation Ditches.

side slopes of $1\frac{1}{2}$ on 1, and a bottom width of 2 ft. A side slope of $1\frac{1}{2}$ on 1 was used because the wet earth in the unlined ditches and the puddle in the puddled ditch would not stand on a steeper slope, and mainly because of the difficulty of oiling the slopes if they had been steeper. The length of the ditches at the top was 50 ft., the ends having also a slope of $1\frac{1}{2}$ on 1; the bottom length was $42\frac{1}{2}$ ft. The top bank width was $4\frac{1}{2}$ ft. making a depth of 14 ft. between the ditches, center to center.

METHOD OF CONSTRUCTION.

The site was not exactly level. It was thought best to make it so, that the ditches might be more nearly under the same conditions. The land was irrigated and plowed and the earth from the higher part of the plot was removed with Fresno scrapers and carried off the site. The ditches were all in cut. After the surface was made level, the grade stakes were located and the excavation of the ditches begun. Each ditch was plowed deeply and the earth removed at first with Fresno scrapers, but as the bottom was reached drag scrapers were used. In this manner the ditches were ex-

cavated roughly to the required cross-section. The total volume of excavation was approximately 500 cu. yds. and the total cost was \$95, or at the rate 19 cts. per cu. yd.

LININGS TO BE USED.

The linings which it was thought advisable to try in the experiment were:

1. Cement concrete.
2. Cement mortar and cement plaster 1 in. thick.
3. Cement lime concrete. It was thought that the addition of some lime to take the place of part of the cement in the concrete similar to No. 1 would perhaps make the concrete more water tight and also slightly cheaper in some localities.
4. Puddle.
5. Road oil in various proportions per square yard of surface and also as a mixture of oil and gravel. The extensive use of oil and its success in road oiling when properly used, especially in southern California, where in many cases the oiled streets are almost as good and even in a few cases better than asphaltum, made it advisable to try oil in several ways.

For a good oiled road, a good foundation and a well-rolled wearing surface are necessary. The quantity of heavy road oil necessary should not exceed $1\frac{1}{2}$ gals. to the square yard.

For canal lining, the conditions are somewhat different from those found in road construction. A good foundation is not necessary. It is impracticable to roll the slopes and beds, and even if practicable, the cost might not justify it. The lack of rolling must be made up by using more oil, and in these experiments a greater quantity of oil was used per square yard than is ordinarily used on roads. Mixtures of oil and gravel were also used in the experiments, and while they were costly, they were at the same time unsatisfactory, proving very poor linings for stopping seepage, as will be shown later.

The order in which the ditches were planned at first is as follows, the ditches being numbered from east to west:

No. 1. Lined with a mixture of heavy road oil and gravel in the proportion of one part of oil to eight parts of gravel. The lining was $3\frac{1}{2}$ ins. thick.

No. 2. Earth (no lining).

No. 3. Lined with a mixture of heavy road oil and gravel in the proportion of one part of oil to six parts of gravel. The lining was $2\frac{1}{2}$ ins. thick.

No. 4. Heavy road oil sprinkled, using $3\frac{3}{4}$ gals. per square yard.

No. 5. Earth (no lining).

No. 6. Thin oil sprinkled, using $2\frac{1}{2}$ gals. per square yard.

No. 7. Clay puddle, $3\frac{1}{2}$ ins. thick.

No. 8. Earth (no lining).

No. 9. Cement mortar, 1 in. thick.

No. 10. Cement concrete, $2\frac{1}{2}$ ins. thick.

No. 11. Earth (no lining).

No. 12. Cement lime concrete, $2\frac{1}{2}$ ins. thick.

It will be noticed that arranging the ditches as above, there are eight ditches lined and four earth ditches with no lining. Each earth ditch has an adjacent lined ditch on each side, so that in case the seepage from the four earth ditches was unequal, the seepage in the lined ditches could be compared with the seepage from the adjacent (or nearest) earth ditch. The lined ditches would also be affected more nearly equally by the seepage from the earth ditch.

METHOD OF FINISHING DITCHES.

After the excavation with teams the ditches were finished by hand in the following manner (Fig. 2): Pieces of timber, 2×3 ins., were placed at the center of the banks between ditches, and extending parallel to them from one end of the ditch to the other; these pieces of timber were placed in the banks and made level. The top of these timbers was at the same level as the banks. Frames or templets were built, as illustrated, of the same size as the finished ditch, ready for the lining. Four of these frames were used, the same one being used for the four earth ditches and for the ditches where the oil was sprinkled on the slopes and bottom. A second form was used for the cement mortar lined ditch; this form was larger than the previous one, allowing 1 in. for the lining. The third form was made large enough so that the ditch finished with this form, after being lined with a $2\frac{1}{2}$ -in. lining, would be of the same cross-section as the earth ditch. The fourth form was used where the ditch was to be lined with a $3\frac{1}{2}$ -in. lining.

These frames were used in the following manner. Beginning at one end the frame was placed in the ditch and the side slopes and bed were cut down until the top piece of the frame would rest on the two pieces of timber on the banks. The frame was then moved forward on these guides and the cross-section was cut down with spades to the proper size. The slopes were finished first and the earth cut from the slopes was removed with a scoop scraper. The cost of finishing was about 1 ct. per sq. ft.

METHOD OF LINING.

No. 1. The oil was heated to a temperature of about 180° Fahr., at which temperature it would flow easily. This heated oil

was mixed with the gravel in the proportion of one part of oil to eight parts of gravel by volume. The mixing was done with rakes and the mixture was very uniform. The sides were lined first.

Pieces of timber $3\frac{1}{2}$ ins. thick were placed on the slopes at right angles to the axis of the ditch, about every 10 ft. The oil-gravel mixture was carried in wheelbarrows and dumped on the slopes between these timbers. A straight edge about 12 ft. long, extending from one timber to the other and worked up and down the slope, regulated the thickness of the lining to $3\frac{1}{2}$ ins. The mixture was tamped while being placed in position.

No. 3. This ditch was lined in exactly the same manner. The mixture used contained one part of heavy Bakersfield oil to six parts of gravel. The thickness of the lining was only $2\frac{1}{2}$ ins.; the slope timbers being therefore $2\frac{1}{2}$ ins. thick instead of $3\frac{1}{2}$ ins. thick, as for No. 1.

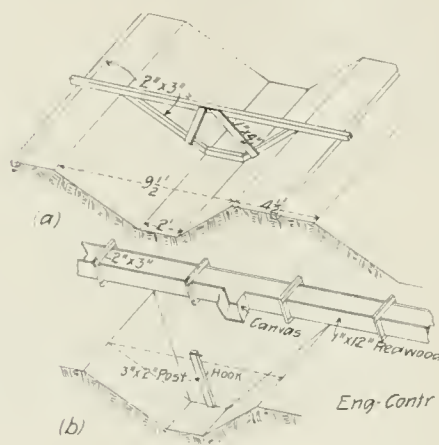


Fig. 2—Method of Finishing the Ditch.

No. 1. This ditch was lined with the same heavy oil. The oil was heated to a temperature of 180° Fahr., and was sprinkled or poured on the slopes with a 3-gal. watering pot, with the rose sprinkler flattened so as to throw a flat stream or sheet of oil on the side of the ditch. The oil was applied mostly on the top of the slope, and as it ran down the slope it was gradually absorbed by the ground—some of it reaching the bottom. An excess of oil accumulating at the bottom was dragged up the slopes by using a stick about 8 ft. in length to which a 2-ft. piece of timber was nailed, at right angles, at one end, and to this piece was nailed a couple of sacks to be used as a mop. If the oil is not applied in large quantities at once, but instead several successive light applications are made, it will not be found necessary to use this mop. The oil was not raked in; the object sought for was to have the oil form a thoroughly saturated crust; while if it was raked or plowed in, the oil may have been disseminated through too thick a layer to form a water-tight crust.

No. 6. The sixth ditch was sprinkled with lighter oil in exactly the same manner as the fourth ditch, using $2\frac{1}{2}$ gals. per square yard.

No. 7. The seventh ditch was lined with clay puddle. The clay was difficult to obtain, having to be hauled about three miles, which made it very costly. The clay contained fine silt and sand. It was sprinkled with water, and when soft was hauled in wheelbarrows and applied in the same manner as the oil-gravel mixture. The thickness of the lining was $3\frac{1}{2}$ ins.

No. 9. The ninth ditch was lined with cement mortar, composed of one part of cement to five parts of gravel. The lining being 1 in. thick, the scantlings or guides placed on the slopes were only 1 in. thick.

No. 10. This ditch was lined with cement concrete $2\frac{1}{2}$ ins. thick, composed of one part of cement to seven parts of gravel and crushed rock, in equal quantities.

No. 12. The twelfth ditch was lined with cement lime concrete $2\frac{1}{2}$ ins. thick, composed of $\frac{3}{8}$ part of cement, $\frac{1}{8}$ part of lime, and seven parts of gravel and crushed rock in equal quantities.

Before lining with cement mortar, cement concrete, and cement lime concrete, the slopes and bed of the ditches were well wetted by sprinkling. These three linings were also kept wet for several days after the construction. The oil ditches had been finished about ten days before the water was turned into them. This was necessary for the oil to seak in well and also for the lighter volatile parts of the oil to evaporate. The water was first turned in on July 23, 1906, and observations were then started.

METHOD OF OBSERVATION.

The ditches were filled each morning to a depth of 2 ft. (approximately), the measurements being taken as soon as filled. Measurements were again taken late in the afternoon and also the next morning before refilling the ditches. The instrument used to take the measurements consisted of a wooden post, 2×3 ins., which was driven firmly in each ditch at the south end. The top of the post was about 3 ft. from the bottom of the ditch. A right-angle screw hook, with the shorter arm filed to a point, was screwed into the post. The depth from the bottom of the ditch to the end of the hook was 2 ft. This served as a guide in filling the ditch, each ditch being filled as nearly as possible up to this hook. For an exact measurement a piece of steel about 5 ins. long, $\frac{1}{8}$ in. thick, and $\frac{3}{4}$ in. wide, was screwed at the top of the post and at right angles to it. This piece of steel projected about 2 ins. beyond the post and its upper edge was beveled. This edge was the index from which the measurements were taken. (Fig. 2b.) The measurements being taken with a plumb-bob attached to a steel tape, the steel tape was placed next to the index and the plumb-bob lowered until the point of the bob touched the water. Accurate measurements could thus be taken to $\frac{1}{2}$ of a hundredth of a foot (.005 ft.).

Evaporation.—The evaporation was determined by means of a galvanized iron tank placed at the north end of the ditches, between ditches No. 6 and No. 7. Meas-

urements were taken in the morning and in the afternoon in the same manner as for the ditches.

From the observations taken beginning with the 23d and extending until the 28th of July, it was found that the lining of ditches No. 1 and No. 3 was entirely unsatisfactory, as the seepage in them was larger than in the earth ditches with no lining. It is probable that the water percolated through this lining and was carried away through gopher and squirrel holes under the lining. In the earth ditches gopher and squirrel holes were found, but could be stopped; but this oil and gravel mixture had sufficient strength not to break through where the holes were, and they could not be discovered. From the observations during these few days it was found that the seepage in all four earth ditches was almost identical, so it was decided to sprinkle oil on two of these earth ditches, using in both cases less oil than was used on ditch No. 4. The gravel-oil mixture was removed from No. 1 and this ditch was used as an earth ditch. Ditch No. 3 was not changed; measurements on this ditch were continued, but it did not improve.

The ditches after July 28th were allowed to dry and after the changes were made were in the following order:

New Order of Ditches.

- No. 1. Earth (no lining).
- No. 2. Heavy oil sprinkled, $2\frac{1}{3}$ gals. per square yard.
- No. 3. Heavy oil and gravel, one part of oil to six parts of gravel ($2\frac{1}{2}$ ins. thick).
- No. 4. Heavy oil sprinkled, $3\frac{3}{4}$ gals. per square yard.
- No. 5. Earth (no lining).
- No. 6. Thin oil, $2\frac{1}{2}$ gals. per square yard.
- No. 7. Puddled clay, $3\frac{1}{2}$ ins. thick.
- No. 8. Heavy oil sprinkled, $3\frac{1}{3}$ gals. per square yard.
- No. 9. Cement mortar, 1 in. thick.
- No. 10. Cement concrete, $2\frac{1}{2}$ ins. thick.
- No. 11. Earth (no lining).
- No. 12. Cement lime concrete, $2\frac{1}{2}$ ins. thick.

Table 1 refers to the ditches after they had been changed.

The water was again turned into the ditches on August 6th, but because of a serious break in the main canal of the irrigation system, the water could not be obtained again until August 28th. Observations were again begun and were taken until September 10th, a period of 14 days.

For the first four days the results were not very uniform; probably because some of the ditches had held water much better than the others during the interval when no water was available for filling them. The rates of percolation per hour given in the table are the rates of percolation for the last ten days. This rate of percolation is computed from the readings taken each day. The seepage and evaporation for each ditch, from the time the ditch is filled to the time when the level of the water is

measured next morning just before filling, give the total seepage and evaporation for that time. Subtracting from this the loss in level due to evaporation gives the loss due to seepage. This quantity divided by the number of hours in which this loss occurred gives the rate of percolation or seepage in feet per hour.

Consulting the table, it will be noticed

square foot of the lining is the actual cost at which the work was done. It does not include the cost of finishing and preparing the ditch for the lining. This cost was about 1 ct. per sq. ft.

The actual cost per square foot for work on a larger scale would naturally be somewhat smaller. The cost given in the table is estimated from similar work in exist-

TABLE 1—SHOWING RATE OF PERCOLATION

No.	Kind of lining	Rate of percolation, in inches, per hour for ten consecutive days										Average	Efficiency ratios
		1st	2d	3d	4th	5th	6th	7th	8th	9th	10th		
1	Earth, with no lining	0.29	0.32	0.31	0.34	0.32	0.33	0.33	0.31	0.32	0.32	0.329	1.00
2	Heavy oil, $2\frac{1}{3}$ gallons per sq. yd.	0.26	0.26	0.25	0.23	0.25	0.22	0.23	0.24	0.32	0.32	0.239	1.37
3	Heavy oil and gravel												
4	Heavy oil, $3\frac{3}{4}$ gallons per sq. yd.	0.22	0.20	0.19	0.18	0.16	0.16	0.16	0.17	0.16	0.16	0.176	2.02
5	Earth, with no lining.	0.40	0.36	0.34	0.34	0.34	0.35	0.36	0.33	0.37	0.36	0.355	1.00
6	Thin oil.	0.35	0.34	0.32	0.31	0.32	0.32	0.33	0.30	0.34	0.32	0.329	1.08
7	Clay puddle	0.21	0.19	0.18	0.18	0.18	0.19	0.17	0.18	0.19	0.18	0.185	1.78
8	Heavy oil, 3 gallons per sq. yd.	0.24	0.23	0.24	0.21	0.24	0.21	0.21	0.20	0.22	0.20	0.220	1.50
9	Cement mortar, 1 inch thick	0.14	0.12	0.13	0.11	0.12	0.13	0.11	0.12	0.11	0.12	0.121	2.73
10	Cement concrete, 3 inches thick	0.06	0.05	0.04	0.04	0.05	0.04	0.06	0.04	0.04	0.04	0.046	7.17
11	Earth, with no lining	0.35	0.36	0.35	0.34	0.32	0.36	0.32	0.32	0.31	0.30	0.330	1.00
12	Cement lime concrete, 3 ins. thick	0.10	0.12	0.09	0.08	0.11	0.10	0.09	0.11	0.12	0.12	0.114	2.90

that the rates of percolation for the three earth ditches were very nearly equal. However, in comparing the seepage from the lined ditches with the seepage from the earth ditches, the relation is obtained by making the comparison with the nearest earth ditch.

The efficiency of a ditch is the ratio between the rate of percolation for the earth ditch and the rate of percolation for the adjacent lined ditch; or efficiency = rate of percolation for earth ditch over the rate

ence and agrees with the cost in the examples mentioned in the first part of this paper. For oil lining the cost would depend largely on the price of oil. The price assumed in preparing table was 2 cts. a gallon for the oil and 1 ct. a gallon to apply it. For cement concrete or cement mortar it is customary to prepare the ditch and finish it carefully. The bottom and side slopes are made even and regular. The cost of finishing on a large scale for first-class work would probably be less than the

TABLE II—SHOWING RESULTS OF EXPERIMENTS.

Description of lining	Average mean sinkage, per cent, in foot for evaporation	Efficiency, in per cent	Per cent saving	Experimental cost of lining per sq. ft.		Actual cost of lining per sq. ft.	
				Cts.	Cts.	Cts.	Cts.
Cement concrete, 3 inches thick.	0.016	7.17	86.6	8.3	1.5	1.5	1.5
Cement lime concrete, 3 inches thick.	0.114	2.90	65.5	8.3	1.5	1.5	1.5
Cement mortar, 1 inch thick.	0.121	2.73	63.3	3.88	1.29	1.29	1.29
Heavy oil, $2\frac{1}{3}$ gals. per square yard.	0.176	2.02	50.4	1.29	1.29	1.29	1.29
Clay puddle, $3\frac{1}{2}$ inches thick.	0.185	1.78	47.8	3.90	1.29	1.29	1.29
Heavy oil, 3 gallons per square yard.	0.220	1.50	38.0	1.00	1.00	1.00	1.00
Heavy oil, $2\frac{1}{2}$ gallons per square yard.	0.239	1.37	27.3	1.00	1.00	1.00	1.00
Thin oil, $2\frac{1}{2}$ gallons per square yard.	0.329	1.08	1.00	1.00	1.00	1.00	1.00
Earth (no lining)	0.355	1.00	0.00				

*Excluding the preparation of the ditch. (Last two columns.)

of percolation for lined ditch. The larger this ratio the more efficient or water tight is the lining.

From the mean sinkage or mean percolation of the several ditches is computed the percentage of saving due to the lining in each case. This saving indicates the probable percentage of water saved from the loss which would take place if the ditch was not lined. The experimental cost per

actual cost on the experimental ditches and would probably not exceed $\frac{3}{4}$ of a cent per square foot. For oil and puddle linings, it would not be necessary to finish the ditch so carefully. The removal of weeds may be the only preparation necessary.

MATERIALS AND COST

Cement.—California Portland cement (Standard Brand), at \$3.00 per bbl. in Modesto.

Time—Reach Harbor time, at \$2.50 per bbl in Modesto.

Broken Stone.—Obtained from Folsom, Cal., at \$3.00 a cu. yd. in Modesto.

Gravel.—Clean river sand, varying from 1 in. pebbles to coarse sand, obtained from Dry Creek, about 3 miles from the site of the experiments, at 10 cts. a cu. yd. The charge for hauling to the site was \$1.50 per cu. yd.

Puddle.—Difficult to obtain. The only clay available was about 3 miles from the site, and it had to be dug with picks. The charge for loading and hauling was about \$1.50 per cu. yd.

Heavy Oil.—Natural crude mineral oil ($10\frac{1}{2}$ to $11\frac{1}{2}$ degrees Beaumé), from the Sunset District near Bakersfield, Cal., containing not less than 60 to 80 per cent by weight of "D" grade asphalt. The percentage of asphalt is not always dependent on the specific gravity. With two oils of the same gravity, one may contain 8 per cent of asphalt and the other none. The oil was obtained at 85 cts. per bbl (42 gallons), delivered on the site.

Light Oil.—Natural mineral oil (16 degrees gravity) containing about 35 to 40 per cent of "D" grade asphaltum. The price was 85 cts. per bbl.

Cost of Labor.—All labor cost \$2.50 for an eight-hour day; one foreman at \$5.00 for an eight-hour day, and a teamster with team \$1.50 per day.

RESULTS OF OBSERVATIONS AND EXPERIMENTS.

A study of the table shows that cement concrete 3 ins. thick stopped 86.4 per cent of the seepage which occurred in an earth ditch excavated in the same material. This percentage would probably have been larger had the earth been more porous; for this would make the loss in earth ditches greater, while the loss from the cement concrete ditch would probably not have been increased. This is true also, but probably not to the same extent, for the other lined ditches. However, it is quite safe to believe that in more porous or open soil the percentage saved by lining would be greater than shown in the table.

While there is no doubt but that cement concrete is the most efficient as regards seepage, it is also the most expensive, being more than six times the cost of the heavy oil lining (3% gals. per sq. yd.), which saves 50.4 per cent of the water which would seep were the ditch not lined. This saving with the concrete ditch is 86.6 per cent, or $1\frac{1}{4}$ times as large. Where water is very valuable there is no doubt but that the concrete ditch is more permanent and economical. But where the water is not so scarce and a little waste will do no damage, the expense of lining the ditch with oil may be justified, while a more expensive lining would be impracticable.

The question will come up: "Is it economical to use oil on a ditch to save 50 per cent or less of the water which is being lost in ditches not lined?" Perhaps there is a great deal of water, and in many irrigated districts the waste of water seep-

ing from the canals and laterals while large is small compared with the larger waste due to over-irrigating the fields and to poor methods of irrigation. These conditions will no doubt better themselves as California becomes more settled and the water is more economically used and more valuable. But even under the present conditions the advantage of lining a canal is not alone the decrease in seepage; other factors should be considered, as mentioned in the first part of this paper. (1st) The prevention of growth of vegetation is an important item and is quite an expense, when in most cases the ditch or lateral must be cleaned out several times during an irrigation season. (2d) The resistance to scouring, on which depends the velocity which the water can be given. (3d) The prevention of squirrels and gophers from burrowing into the banks and bottom of ditches.

The oil will prevent vegetation and the burrowing of animals on the banks and bottom of the ditch. This is clearly shown by an example near Lemoore.

That oil will prevent scouring to a great extent and will allow a much higher velocity of flow of water than the earth ditch may be expected, when we consider its resistance to wave action at the Ivanhoe Reservoir, near Los Angeles, the reservoir being lined with oil, and the resistance of oiled roads to cutting under the action of running water. This toughness of oil lining was also noticed in filling the experimental ditch each morning. When the water carried by the wooden flume discharged into each ditch through the gate it had a fall of at least one foot. It was difficult to prevent the sloping ends of the earth and puddle ditches from being badly cut up by the erosive force of the falling water. These ends had to be well protected with heavy canvas, and even the erosion could not be altogether prevented. The ditches lined with oil resisted the erosion and showed no cutting, although they were not protected with canvas.

A letter from the superintendent of the Modesto Irrigation District, dated January 21, 1907, states that the ditches were examined by him after the recent heavy rain-falls. The banks of the earth ditches were badly washed where the water ran in; the clay puddle was slightly so, but the oiled ditches showed absolutely no sign of wash. The oil linings are all hard and firm and scratch almost like concrete.

This resistance to erosion will permit in a saving of cross-sectional area due to the possibility of giving the water an increased velocity. The higher velocity will prevent the deposition of silt to a great extent and there will be a consequent decrease in the cost of operation and maintenance.

The puddle lining in the experiment showed a saving in seepage nearly equal to the heavy oil lining when 3% gals. of oil per sq. yd. was used, and a greater saving than the other oil linings. This puddle lining, whose thickness was $3\frac{1}{2}$ ins., would, no

doubt, if made thicker, be more efficient than any of the oil linings as regards seepage; but clay puddle when wet becomes very soft and will not resist the erosive force of the flowing water unless the velocity is very small. It will not prevent the growth of weeds. For these reasons it is probably not as efficient for canal linings as oil. But where clay is plentiful it would be preferable for reservoir lining. The slopes should, however, be protected against the erosive action of the waves by the use of cobblestones or other protection.

The use of oil in lighter quantities, while not very efficient in preventing seepage, will no doubt prevent the growth of vegetation, as illustrated by the example of the ditch near Lemoore. In this case only $1\frac{1}{2}$ gals. per sq. yd. was used and this quantity has been sufficient to prevent vegetation.

Cement mortar plaster, so extensively used in southern California, showed a saving in seepage water of 63 per cent. Better results were expected, and it is probably safe to expect a greater saving where good work is done, especially where the work is constructed in cold weather. This lining had to be applied when the temperature in the field was probably 110° or over. The cement mortar was mixed in small quantity and quickly applied. As soon as the setting had started the lining was sprinkled and covered with wet canvas, but even with these precautions better work could be done in cooler weather.

This plaster, while very efficient and economical on small ditches, would not be of sufficient thickness and strength to be used on the larger canals and laterals of larger irrigation systems, where a thickness of from 2 to 4 ins. would no doubt be successful.

The rock toe at the upstream or south end of Gatun Dam is almost up to the elevation decided on, that is, 60 ft. above sea level, states the Canal Record. The toe is constructed of Bas Obispo rock and runs gradually up to its highest point. It extends from the old line of the Panama railroad to the spillway. When completed the toe will be at an elevation of 60 ft. along its entire length, that is, clear across the valley. Spoil from the cut at Mindi is being dumped on the north toe of the dam, and this toe also is assuming something of the appearance it will have when completed. The dump will be extended clear across the valley and so far north that it will include the ground on which the Gatun Island hotel is located. Between these two toes, a distance of 1,700 ft., the hydraulic fill will be made, or, in other words, the dam proper will be located. The unwatering of the old bed of the Chagres, between the two toes, is almost completed and it will be possible in a few weeks to begin the work of scraping the layer of silt from the bottom. The whole dam site will be cleared of the loose earth covering before the hydraulic fill is begun.

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are: First, to inform civil engineers and contractors of the articles and papers of merit that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

- American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.
American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.
American Engineer and R. R. Journal (Am. Engr. & R. R. J.), New York, N. Y.; m; 7x10 in.; 20 cts.
American Gas Light Journal (Am. G. L. J.), New York, N. Y.; w; 10x13 in.; 10 cts.
American Institute of Electrical Engineers Proceedings (Am. I. of E. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.
American Society of Civil Engineers Proceedings (Am. Soc. C. E. Proc.), New York, N. Y.; m; 4x7 in.; 75 cts.
American Society of Mechanical Engineers Proceedings (Am. Soc. M. E. Proc.), New York, N. Y.; m; 4x7 in.; 50 cts.
Annales des Ponts et Chaussées (An. P. & C.), Paris, France; m. Architects and Builders Journal (Arch. & Bldrs. J.), Baltimore, Md.; m; 9x12 in.; 20 cts.
Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
International Railway Congress Bulletin (Int. Ry. Cong. Bul.), Brussels; m; 50 cts.
California Journal of Technology (Cal. J. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x19 in.; 20 cts.
Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
Canadian Mining Journal (Can. Min. J.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
Canadian Municipal Journal (Can. Mun. J.), Montreal, Que.; m; 6x10 in.; 10 cts.
Canadian Society of Civil Engineers Proceedings (Can. Soc. C. E. Proc.), Montreal; m; 4x7 in.; 50 cts.
Carpenter and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
Cement Age (Cem. Age), New York, N. Y.; m; 4x7 in.; 10 cts.
Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
Electric Railway Journal (Elec. Ry. J.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electric Traction Weekly (Elec. Trac. Wkly), Cleveland, O.; w; 7x10 in.; 10 cts.
Engineer (Engr. Lon.), London, England; w; 4x11 in.
Engineer (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Engineer (Eng.), London, England; w; 8x11 in.
Engineers' Club of Philadelphia Proceedings (Engr.' Club, Phila. Proc.), Philadelphia; qr; 4x7 in.; 25 cts.
Engineering-Contracting (Eng.-Contr.), Chicago, w; 7x10 in., 10 cts.
Engineering Digest (Eng. Dig.), New York; m; 5x8 in.; 20 cts.
Engineering and Mining Journal (Eng. & Min. J.), New York; w; 7x10 in.; 15 cts.
Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.
Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
Le Genie Civil Paris, France; w.
Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.
Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
Industrial World (Ind. Wld.), Pittsburgh, Pa.; w; 7x10 in.; 10 cts.
Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; \$1.
Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.
Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
Iron Trade Review (Iron T. Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.
Journal Western Society of Engineers (Jl. W. Soc. Engr.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
Journal of Electricity, Power and Gas (Jl. Elec., P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Mines and Minerals (Ml. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.
Mining and Scientific Press (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Modern Machinery (Mod. Mch.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Municipal Journal and Engineer (Mun. J. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 8x11 in.; 15 cts.
Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 in.; 15 cts.
Power and Engineer (Pwr. & Engr.), New York; m; 7x10 in.; 20 cts.
Railway Age Gazette (R. R. Age. Gaz.), New York; w; 8x11 in.; 15 cts.
Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Roadmaster and Foreman (Rd. & For.), Chicago; 7x10 in.; 10 cts.
Rock Products (Rk. Prod.), Chicago, Ill.; bi-w; 9x11 in.; 10 cts.
Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr; 4x7 in.; 50 cts.
Schweizerische Bauzeitung, Zurich; w.
Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
Sibley Journal of Engineering (Sib. J. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.
Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.
U. S. Department of Agriculture Bulletin (Dept. Agr. Bul.), Washington, D. C.; 4x7 in.
U. S. Geological Survey Bulletin (Geo. Surv. Bul.), Washington, D. C.; 4x7 in.
Waterproofing and Fireproofing (W. P. & F. P.), New York, N. Y.; m; 5x8 in.; 10 cts.
Zeitschrift d. Oest. Ing. u. Arch. Ver. Vienna; w.
Zeitschrift d. Ver. Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Effect of Traction Engine and Heavy Motor Traffic Upon Road Foundations. By R. J. Thomas. Surveyor, Nov. 13, 1908; 2 pp.

A paper submitted at the First International Road Congress.

Amount of Materials Required for Cement Sidewalk Construction. Eng.-Contr., Nov. 1, 1908; 2 p.

Contains two tables—one showing the volume of concrete base and mortar wearing surface per 100 sq. ft. of cement walk of various thicknesses, and the other showing quantities of cement, sand and broken stone required for 100 sq. ft. of sidewalk for base, and for surface finish for different proportions of concrete and different thicknesses of walk.

The Destructive Effect of Automobiles Upon Macadam and the Use of Asphaltic and Tar Binder in Road Building. Eng.-Contr., Nov. 1, 1908; 1½ pp.

Abstracts from addresses at the Good Roads and Legislative Convention at Buffalo, N. Y., showing that some sort of asphaltic or tar binder must hereafter be used in road building.

Paris International Road Congress. Surveyor, Oct. 23, 1908; 8 pp.

Contains summary of the conclusions reached by the Congress. The article also includes a paper by F. G. Carpenter, describing the construction and maintenance of roads in West Riding, Yorkshire, England, and the conclusions of the Belgian Institution of Engineers and Traders in connection with paving materials.

Wear and Tear of Roads. By W. J. Taylor. Surveyor, Nov. 13, 1908; 2 pp.

A paper submitted at the First International Road Congress. In it the author discusses the effect of motor traffic on rural main roads, and shows by a diagram the changes in materials and increased cost of maintaining road surfaces on the 541 miles of road under his care.

The Proper Construction of Brick Street Pavements. By Will P. Blair. Mun. Eng. Mag., November, 1908; 4 pp.

A practical paper on the construction of brick pavements. The paper points out the essential features of construction which should be followed in order to secure a first-class brick pavement.

Practical Results of the Municipal Control of Shade Trees. By William Solotaroff. Mun. Eng. Mag., November, 1908; 3½ pp.

Describes the organization and methods of work of the municipal shade tree commission of East Orange, N. J.

Railway Sprinkling Cars. Mun. Jl. & Eng., Nov. 4, 1908; ½ p.

Describes the new street sprinkling cars recently put in service at Chicago, Ill., by the Chicago City Ry. Co.

Method of Road Maintenance in Cuba. By Chas. McKercher. Eng.-Contr., Nov. 25, 1908; 1½ p.

Describes system of road maintenance of the Department of Public Works of Cuba.

New Pavements and Construction Methods. Mun. Jl. & Eng., Nov. 4, 1908; 3 pp.

Abstracts of several papers on pavements presented at the recent convention of the American Society of Municipal Improvements. The article contains descriptions of various patented pavements, including Hassam, Imperial Mineral Rubber and the Blome system of concrete pavement construction.

Cement Sidewalks. Mun. Jl. & Eng., Nov. 4, 1908; 3½ pp.

The article treats of the selection of the best materials and methods of construction for cement sidewalks, and points out faulty methods sometimes employed. Included in the article is a table showing the specified requirements for cement sidewalks in various cities.

The First International Road Congress. Gd. Rds. Mag., November, 1908; 15 pp.

A general account of the First International Road Congress at Paris. The article contains the conclusions arrived at by the Congress on various matters appertaining to road construction; also the impressions of several American delegates on European roads and the results accomplished by the Congress.

The Effect of Modern Traffic on Broken Stone Roads. By L. W. Page. Gd. Rds. Mag., November, 1908; 1½ pp.

A paper submitted at the First International Road Congress. In it Mr. Page discusses the effect of automobiles on macadam roads and concludes that the most injurious action of motor traffic is due to the shearing force of the driving wheels.

Maintenance of Highways in View of the Advent of the Motor Vehicle. By Clifford Richardson. Gd. Rds. Mag., November, 1908; 3½ pp.

Describes the various methods which have been employed in the treatment of macadam roads and describes briefly the asphaltic concrete pavement laid on the Thames embankment in London. The paper was submitted at the First International Road Congress.

Macadam Road Surfacing in the Past and for the Future. By W. W. Crosby. Gd. Rds. Mag., November, 1908; Eng.-Contr., Nov. 25, 1908; 2 pp.

Paper submitted at the First International Road Congress. The general construction of macadam pavements is described, and the effects of motor traffic considered.

Road Construction—How It Is Accomplished in Pennsylvania. By R. D. Beman. Gd. Rds. Mag., November, 1908; 1 p.

Describes the work of the Pennsylvania State Highway Department in the construction of State Oil Roads.

What the United States Government Is Doing in Road Building. By Allerton S. Cushman. Gd. Rds. Mag., November, 1908; 1½ pp.

Describes in a general way the work of the Federal Government in doing for road betterment in the various states.

Petrolithic Pavement: Method of Construction, Organization of Working Force and Data on Work Done. By J. C. Black. Eng.-Contr., Nov. 14, 1908; 2 pp.

Describes method of constructing petrolithic pavement and the organization of the working force and equipment to obtain the best results. Data are also given on the average amount of labor and material required for constructing the pavement.

Experimental Earth Roads in Illinois. Eng.-Contr., Nov. 11, 1908; 1 p.

Describes construction by Illinois Highway Commission of experimental sections of earth roads, using a road roller with spuds in the rear wheel.

Labor Cost of Constructing Eight Macadam Roads and Data on the Average Labor Cost of Macadam Construction. Eng.-Contr., Nov. 18, 1908; 4½ pp.

Gives the detailed labor cost per cu. yd. for placing stone and per sq. yd. of finished pavement for eight macadam roads. The article also includes an estimate of the cost of macadam roads, based upon data obtained by the Illinois Highway Commission during the past two years in the construction of 13.76 miles of road.

Experience With the Road Drag Under Various Conditions. Eng.-Contr., Nov. 25, 1908; 2½ p.

Gives principal points that come up in the everyday use of the road drag.

Roads for Heavy Traffic. By H. P. Maybury. Eng. Rec., Nov. 28, 1908; ¾ p.

A paper read before the International Road Congress at Paris. Gives an account of the kinds of roads built in Kent county, England, for heavy traffic and the experience gained from experiments made there.

SEWERS.

Cost of Sewers in a Canadian City. Eng.-Contr., Nov. 4, 1908; 1-6 p.

Table showing cost per lineal foot of sewer construction at Sydney, Nova Scotia.

Septic Tank Patents. By Prof. A. Marston. Mun. Eng. Mag., November, 1908; 5 pp.

The article treats of the litigation over the Cameron patents for septic tanks and contends for adoption of a classification and nomenclature of sewage tank corresponding to the court's decision. A brief history of the patents of the septic tank decision. The paper was read before the American Society of Municipal Improvements at its recent annual meeting.

The Contractor's Plant for Building a Triple Barrel Reinforced Concrete Sewer. Eng. Rec., Nov. 28, 1908; 2 pp.

Description is given of the contractor's plant being used in building the concrete sewer in Avenue A in the Bronx, New York City. The plant for handling concrete is given special attention.

WATERWORKS AND HYDRAULICS.

Unit Cost of Laying 107,877 Ft. of Water-mains at Cleveland, O. Eng.-Contr., Nov. 4, 1908; ½ p.

The main ranged from 3 ins. to 30 ins. Prices of materials and wages of labor are stated and itemized cost is given for each size of main.

Cincinnati's Water Filtration Plant. Mun. Jl. & Eng., Nov. 4, 1908; 5 pp.

General illustrated article, describing the water filtration plant of Cincinnati, O.

Water Filtration at Pittsburgh. Mun. Jl. & Eng., Nov. 11, 1908; 3 pp.

General illustrated article, describing the filtration system of Pittsburgh, Pa.

Report on Rebuilding the Austin Dam. Eng. News, Nov. 12, 1908; 2½ p.

Reprint of Board of Engineers on the rebuilding of the large masonry dam destroyed by flood in 1900. The conditions are studied and the precautions to be taken to prevent future failure are outlined. An estimate is given of the cost of the reconstruction.

Rubber Pipe Joints. By Robert S. Weston. Jl. N. E. W. W. Asso., September, 1908; 10 pp.

Describes a rubber pipe joint that has been used for some years in Germany and compares the cost of this joint with lead.

Adjustment of Diversion Damages by Storage Compensation. By Robert E. Horton. Jl. N. E. W. W. Asso., September, 1908; 20 pp.

A discussion of this subject gives the English practice. Cites difficulties encountered in the United States, and gives cases as illustrations. Also has bibliography at end of paper.

Notes Concerning the Water Purification Plant Now Under Construction for the City of Toledo, Ohio. By Wm. G. Clark. Proc. Ohio Soc. Mech. Elec. and Steam Eng., November, 1908; 7 pp.

An account of the new waterworks of Toledo, with a description of the supply of the purification plant, the pumping station and other details of the system.

Meters and Water Consumption of the Hartford Waterworks. By Erman M. Peck. Jl. N. E. W. W. Asso., September, 1908; 6 pp.

Gives the experience of the city of Hartford during the seven years since meters have been used, showing a reduced consumption of water per capita from 846 gals. per day to 59.1 gals.

Subaqueous Pipe and Electric Cableway at Gloucester, Mass. By H. W. Spooner. Jl. N. E. W. W. Asso., September, 1908; 17 pp.

Gives an account and describes the methods used in constructing the tunnel used as a subaqueous pipeway. Illustrated by photographs.

The Hydro Electric Plant of the Uncas Power Co. at Scotland, Conn.. Eng. Rec., Nov. 21, 1908; 4½ pp.

A complete description is given of this plant and the construction of the dam and appurtenances. The dam is a hollow concrete structure. Difficulty was encountered with the foundation. Illustrated with photographs and drawings.

Some Common Mistakes in the Construction and Maintenance of Water Systems. By W. G. Yorston. Con. Eng., Nov. 6, 1908, 3½ pp.

Discussion of the water supplies of small towns. Comments on the size of the water mains, also on the weight of castiron pipe, distributing mains, special castings, hydrants and valves. Suggests many improvements and savings. Under maintenance, the author discusses service, water charges and the care of the system. A paper delivered before the Nova Scotia Society of Engineers.

The Torresdale Preliminary Filters of the Philadelphia Water Supply. Eng. Rec., Nov. 14, 1908; 3½ pp.

A description of the filter plant of the city of Philadelphia at Torresdale. The plan of double filtration consists of preliminary mechanical filtration in order to increase the capacity of the sand filters. This article is devoted to the mechanical filters.

DRAINAGE AND IRRIGATION.

Methods and Cost of Constructing a Farm Drainage System. Eng.-Contr., Oct. 31, and Nov. 4 and 18, 1908; 9½ pp.

A series of continued articles describing in detail the construction of and the cost of a drainage system for a large farm, including open ditch, tile ditch, bridges, catch basins, outlets, etc. An article of great value on farm drainage methods and costs.

Methods of Deriving Benefits From County Drainage Systems in Missouri. By C. E. Jacoby. Eng.-Contr., Nov. 4, 1908; ¾ p.

Describes methods in state named of deriving benefits where a river or creek channel is cleaned out and straightened.

National Irrigation and Flood Control. By Arthur P. Davis. Eng. Rec., Nov. 14, 1908; 1 p.

Shows the importance of the storage of flood water for irrigation purposes; also how this storage will prevent dangerous floods along the streams upon which storage has been made. A list of 27 projects for irrigation now under way by the Reclamation Service is given.

Construction of the Pathfinder Dam, North Platte Project, U. S. Reclamation Service. By E. H. Baldwin. Eng. Rec., Nov. 7, 1908; 2½ pp.

Gives a description of this dam and of the progress of the work done by the contractors, supplemented with photographs of plant used and of the dam. Describes the method of hauling 56,000 bbls. of cement over 45 miles of mountainous roads.

RIVERS, HARBORS AND CANALS.

Proposed Reservoir System in the Ohio River Basin. By M. O. Leighton. Eng. News, Nov. 5, 1908; 3½ pp.

This paper is a reply to a paper by Maj. H. C. Newcome, which combated Mr. Leighton's argument previously published in favor of flood control of the Ohio river by means of reservoirs.

Movable Dam and Lock at the Power Plant of the Chicago Drainage Canal. Eng. News, Nov. 12, 1908; 3½ pp.

In constructing the water power plant of the Chicago Drainage Canal provision had to be made in building the dam for regulating and controlling the flow, and also for the passage of canal boats. This provision comprised a canal boat lock, a vertically pivoted butterfly dam and two horizontally pivoted movable curb dams. Full drawings and a general description of these several structures are given in this article.

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The Municipal Ferry House Substructure, New York. Eng. Rec., Nov. 7, 1908; 4 pp.

Gives a description of the ferry slips and substructure of the houses that are being built near Battery Park, New York City. Illustrated with a large number of drawings showing details of the plans.

Methods and Costs of Dredging the St. Lawrence River. Eng.-Contr., Nov. 11, 1908; 4 pp.

A description of the dredges used and the character of the work is given. Data on the cost of maintaining dredges is given, and methods of doing the work are described. Cost for a number of years is given in great detail, showing nearly every item of cost.

The Floods of the Mississippi Delta; Their Causes and Suggestions as to Their Control. By Wm. D. Pickett. Proc. Am. Soc. C. E., November, 1908; 20 pp.

Statistics are given as to the delta of the Mississippi river, and also as to the flood periods and the floods. Their causes are shown and suggestions as to their control by dams is made.

RAILWAYS.

Detailed Cost of Laying Side Tracks and Switches, Including Labor and Materials. Eng.-Contr., Nov. 4, 1908; 1½ pp.

Gives detailed cost of eight examples of side track and switchwork. Valuable data on a class of work for which costs have been rarely printed.

Life of Manganese Steel Rails on Curves—From Service Tests Made on the Boston Elevated Railway. By H. M. Steward. Eng.-Contr., Nov. 4, 1908; 1¼ pp.

Gives results of tests, showing amount and character of wear on rails of various steels as determined by tests on curves of Boston Elevated Railway. Comparative costs of manganese and carbon steel rails based on relative wear are given.

Equipment for Electric Operation of the St. Clair Tunnel of the Grand Trunk Railway. Eng.-Contr., Nov. 11, 1908; 5 pp.

General description of tunnel and traffic conditions, with more complete description of electric locomotives, drainage and power plants and transmission line.

The Cost of Grading Two Hundred Miles of Railroad. Eng.-Contr., Nov. 11, 1908; ½ p.

Gives the cost of 200 miles of the Grand Trunk Pacific on heavy rock construction. Divides the various items of costs up in percentages.

The Gardenville Yard of the New York Central Lines. Eng. Rec., Nov. 7, 1908; 1½ pp.

A description of the new freight yards that are to be built on the outskirts of Buffalo, N. Y., to accommodate 21,400 cars. It will be one of the largest yards in the country.

The Tunnel of the New York, New Haven & Hartford Railroad at Providence. Eng. Rec., Nov. 7, 1908; 4 pp.

Describes this tunnel and the method of making the survey and locating it through a built-up city. The excavation and the work of lining it in the concrete, showing methods used, is described at some length.

Electric Railways in the Ohio Valley Between Steubenville, Ohio, and Vaucliff, Pa. By George B. Francis. Proc. Am. Soc. C. E., November, 1908; 18 pp.

Description is given of 44 miles of double track electric railway built along the Ohio river. Profits of the road are given. The grading and track construction, the bridges and fare requirements are described, as well as the transmission and feeder lines.

BRIDGES, BUILDINGS AND FOUNDATIONS.

Methods of Cofferdam Construction. Eng.-Contr., Nov. 25, 1908; 1½ pp.

Describes methods of constructing cofferdams as compiled by a committee of the As-

sociation of Railway Superintendents of Bridges and Buildings.

Method of Sinking a Foundation for a Bridge Pier. Eng.-Contr., Nov. 4, 1908; 1¼ pp.

Describes method of sinking pivot pier for Grand Trunk Pacific Ry. bridge at Fort Williams, Ont. The pier was sunk by the open caisson method to rock 90 ft. below water surface; it was 26 ft. in diameter above water and contained 3,000 cu. yds. of concrete.

Methods and Cost of Constructing a Wooden King Post Truss Bridge With Concrete Abutments in Cuba. By C. M. Kercher. Eng.-Contr., Nov. 11, 1908; ¾ p.

Truss of 32.8 ft. span, built of native woods on concrete wing wall abutments. Itemized costs of all work and materials are given.

Reports on the Sufficiency and Safety of the Blackwell's Island Bridge, New York City. Eng.-Contr., Nov. 18, 1908; 1½ pp.

Gives conclusions on above questions of two expert reports made by Prof. Wm. H. Burr and by Boller & Hodge, bridge engineers. Reports show that bridge will be overstressed by specified loadings, but is safe for certain smaller loadings, as explained.

Stresses in the Blackwell's Island Bridge Under Full Specified Loading. Eng. News, Nov. 19, 1908; 3 pp.

Gives in tabular form the stresses in members of this bridge resulting from the full specified loading as they were figured by Boller & Hodge. The results are briefly discussed.

Methods of Calculating Stresses for the Blackwell's Island Bridge, as Used in Boller & Hodge's Recomputation. Eng. News, Nov. 19, 1908; 1½ pp.

Explains the simplified method employed by Boller & Hodge for computing the stresses in this continuous structure.

Data of Weight and Cost of Five Steel Arch Bridges. Eng.-Contr., Nov. 4, 1908; ¾ p.

Gives weight, quantities and in some cases cost of five steel arch bridges, including the 840-ft. arch at Niagara.

Safety and Carrying Capacity of the Blackwell's Island Bridge: Two Expert Reports. Eng. News, Nov. 12, 1908; 6¾ pp.

Reprint of the main reports of Prof. Wm. H. Burr and of Boller & Hodge to the Department of Bridges of New York City. The reports show that the loading assumed in the original design would greatly overstress the structure, gives the safe loadings for the bridge as built, and suggests changes to be made.

Timber Girder Bridges on the Queensland Government Railways. Eng. News, Nov. 5, 1908; ¾ p.

Gives drawings of standard timber bridge construction employed on the railways named. Text merely calls attention to the drawings.

The Mill River Bridge of the New York, New Haven & Hartford R. R. Eng. Rec., Nov. 14, 1908; 2 pp.

A description of this bridge and its substructure is given, illustrated with plans, and showing the method of sinking the caissons for the foundations.

Substructures of Bridges on the Spokane, Portland & Seattle Ry. Eng. Rec., Nov. 14, 1908; 1½ pp.

A description is given of the various foundations and piers of this new Western line, with some methods used in their construction.

The Construction of the Manhattan Bridge Approaches. Eng. Rec., Nov. 21, 1908; 1½ pp.

A description is given of some of the methods used in constructing these approaches.

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Methods and Costs of Testing for Bridge Foundations. By F. H. Bainbridge. Eng.-Contr., Nov. 25, 1908; 2 pp.

Tests were made by either an open pit or well for shallow foundations and the core drill for deep foundations. Description is given of the work done for testing bridge sites on the Chicago & Northwestern Ry. Cost of the work done is also shown.

The Increase of the Gunpowder River Water Supply for Baltimore, Md. Eng. Rec., Nov. 28, 1908; 2/3 p.

Tells of the scheme to increase the water supply by building a reservoir, and gives statistics as to stream flow.

CONCRETE AND REINFORCED CONCRETE.

Methods and Cost of Constructing a Well by Sinking Reinforced Concrete Caisson Curbings. Eng.-Contr., Nov. 11, 1908; 1 1/2 pp.

The well was 24 ft. deep and 8 ft. interior diameter and was sunk by open caisson work, building up the caisson of concrete in forms as the sinking progressed. Details of the caisson construction and of the forms are given, the methods of doing the work are described and the itemized cost of the work is given.

Methods and Cost of Constructing Concrete Vaults for Valves. By Carroll Beale. Eng.-Contr., Nov. 18, 1908; 1 1/2 pp.

Shows standard vault construction of concrete with all quantities and dimensions for various sizes. Also shows construction of valve casing foundations of molded concrete rings, with drawings of ring molds, and compares cost with cost of brickwork foundation. A valuable article for city engineers and waterworks superintendents.

Reinforced Concrete Intercepting Sewer. By Alexander J. Taylor. Mun. Jl. & Eng., Nov. 18, 1908; 5 pp.

Describes the construction of a reinforced concrete sewer at Wilmington, Del. Methods of making and laying concrete pipes are described and several details of construction are given.

The Early Cement Makers. Eng.-Contr., Nov. 25, 1908; 2 2/3 pp.

An address by Robert W. Lesley, giving an historical and biographical account of the pioneers in the cement industry and an estimate of the character and value of their work. An interesting article to cement users.

Method and Cost of Constructing a Reinforced Concrete and Steel I-Beam Bridge. Eng.-Contr., Nov. 25, 1908; 1/2 p.

The bridge consisted of light steel I-beams, imbedded in reinforced concrete and carrying reinforced concrete floor slabs. Novel methods of construction were used and are described and costs are given.

Construction of a Reinforced Concrete Intercepting Sewer. By Alexander J. Taylor. Eng. Rec., Nov. 7, 1908; 2 pp.

A paper read before Am. Soc. of Mun. Imp. Describes in detail the work of building a sewer in Wilmington, Del.

Methods of Waterproofing Concrete Floors for Railway Bridges With Some Figures on Cost. Eng.-Contr., Nov. 4, 1908; 3 pp.

Abstract from committee report of the Association of Railway Superintendents of Bridges and Buildings, describing and illustrating methods of waterproofing concrete bridge floors as employed by the New York, New Haven & Hartford, Pennsylvania, Chicago & Northwestern and Lake Shore & Michigan Southern railways.

Methods of Constructing Concrete Foundations for Street Railway Track, Using a Special Mixer Mounted on a Car. Eng.-Contr., Nov. 4, 1908; 3/4 p.

Describes the car-mounted mixing plant used by the Chicago City Ry. in placing concrete foundation for track, outlines methods of work, gives organization, quantities and estimate of cost.

Failure of a Reinforced Concrete Floor of Unusual Design. By Alexis d'O. Saurbrey. Eng. News, Nov. 5, 1908; 1 1/4 pp.

Describes construction of building and shows general details of girders which failed, with account of nature and character of failure. The method adopted for strengthening the structure is also described and illustrated.

Casting the Concrete Lions for the Connecticut Ave. Bridge, Washington, D. C. Eng. News, Nov. 19, 1908; 1 1/4 pp.

Describes the construction of the lions, the molds employed and the methods used in molding the concrete.

Study of Reinforced Concrete Culverts, C., M. & St. P. Ry. Ry. & Eng. Rev., Nov. 7, 1908; 3 pp.

Describes the various types of culverts used and comments on the merits of the different types. Also gives cuts of the culverts, and for box culverts both reinforced concrete and plain concrete is used. Gives table of quantities and cost per lin. ft. of different sizes and types of culverts.

Painting Cement Surfaces. By P. W. Nelson. Con. Eng., Nov. 6, 1908; 3/4 p.

A paper delivered before the Ohio State Association of Painters and Decorators. Tells of unsuccessful efforts to paint cement surfaces and then describes a method that, it is stated, has been used with success.

A Large Retaining Wall at Tacoma. By Louis P. Zimmerman. Eng. Rec., Nov. 28, 1908; 3/4 p.

A description is given of the design and building of one of the largest concrete retaining walls built on the Pacific Coast.

EARTH AND ROCK EXCAVATION.

New Record Established in Driving Hard Rock Tunnels. By J. B. Lippincott. Eng. News, Nov. 19, 1908; 1/2 p.

Describes method of driving 12x12-ft. tunnel through granite for Los Angeles aqueduct. Record for 31 days was 466 ft.

Machines for Boring Rock Tunnels. Eng. News, Nov. 19, 1908; 3 1/4 pp.

Describes and illustrates a machine for boring rock tunnels. The machine is designed to chip away the heading face by the action of a number of pneumatic hammers fitted with chisel or point bits, a sufficient number of hammers being used that, when the holder or head on which they are mounted is rotated in the axis of the tunnel every part of the circular face is reached by the bits.

The Seattle Regrade, With Particular Reference to the Jackson St. Section. By L. P. Zimmerman. Eng. News, Nov. 12, 1908; 2 2/3 pp.

Describes in a general way the work to be done in regrading and leveling the hilly streets and adjacent property on which the city of Seattle, Wash., is built. Hydraulic grading is chiefly employed and the pumping plant is described and the method of conveying and wasting the water. The results of the regrading on sanitary conditions and on the general appearance of the city are discussed.

Cost of Drilling Holes With a Well Drilling Machine. Eng.-Contr., Nov. 18, 1908; 1/3 p.

Gives the cost in detail of drilling 13 holes, in all 2,885 lin. ft. Character of ground is also described.

Dredging Earth and Rock at Panama. Eng.-Contr., Nov. 18, 1908; 1/2 p.

An account of the methods of dredging used to dredge the rock on the Panama Canal and excavate the earth.

Cost of Canal Excavation and Concrete Work for Uncompahgre Irrigation Project, Colorado. Eng.-Contr., Nov. 18, 1908; 1/2 p.

Gives the cost of this work, showing main items of expense and also the cost of the engineering work.

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A Novel Type of Dredge for Drainage Ditching With Some Records of Its Operation. Eng.-Contr., Nov. 18, 1908; 2½ p.

Describes a new type of dredge, designed to work on level ground, which is not too soft and gives some records of operation.

Method and Cost of Gold Dredging by the Elevating Bucket. Eng.-Contr., Nov. 1, 1908; 2 pp.

This article discusses methods of digging gold-bearing gravel in the various types of dredges and shows the superiority of the elevating bucket. Describes in detail one of the latest built dredges of this type and gives methods of operating the dredge with the cost of a month's work.

SURVEYING AND DRAFTING.

Staking Out Curves in Rough Ground. By Robert Laird. Eng.-Contr., Nov. 25, 1908; 1¾ pp.

Describes in detail methods of staking out curves in rough or inaccessible ground by short or semi-tangents to the curve. An article of interest to railway locating engineers.

Blue Print Paper Cutting Table. Eng.-Contr., Nov. 1, 1908; ¼ p.

Illustrates and describes a table which allows blue print paper to be quickly and accurately cut to desired size.

Cost of Topographical Survey. Eng.-Contr., Nov. 11, 1908; ½ p.

Gives cost of survey covering 900 acres of rolling hills.

A Diagram for Calculating Penstocks. By Richard Muller. Eng. Rec., Nov. 14, 1908; 1 p.

A diagram is shown for use in designing penstocks and a mathematical discussion is given to show the accuracy of the diagram.

COST, KEEPING AND MANAGEMENT.

A Criticism of the Competitive Contract System. By C. H. Eglee. Eng.-Contr., Nov. 18, 1908; 1½ pp.

An argument favoring the cost-plus-a-fixed-sum contract, as compared with the straight lump sum contract. This is a well written presentation of its subject and should be read by all engineers. An editorial in the same issue reviews some of Mr. Eglee's remarks and points out certain merits of the lump sum system of contracting.

Training Workmen in Habits of Industry and Co-Operation. By H. L. Gantt. Am. Soc. M. E. Proc. November, 1908; 12 pp.

In this paper the author tells of the task and bonus system of rewarding labor and comments on the method of operating this system and the great advantages that have been obtained by it in various manufacturing plants, especially along the line of better habits of work and co-operation of the workers.

The Office, Accounting and Cost Keeping System; Department of Greater Water Supply, People's Water Co., Oakland. By Langdon Pearce. Eng.-Contr., Nov. 14, 1908; 2½ pp.

This company, in addition to the operating department, has for more than a year been carrying on engineering and construction work, and the organization, with the method of accounting and cost keeping, is described. Samples of forms used are shown, and drafting room standards are shown. Many features of office work are described and also field work. The indexing of records is also shown.

MISCELLANEOUS.

Cost of a Dry Masonry Box Culvert. Eng.-Contr., Nov. 11, 1908; ¼ p.

Shows sketch plan of 3x3-ft. box culvert, 36 ft. long, of dry masonry, and gives itemized cost.

Industrial Photography. By S. A. Hand. Eng. News, Nov. 19, 1908; 3 pp.

An interesting and practical discussion of apparatus and methods to be employed in

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In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

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photographing machinery, shop interiors and manufactured products for trade and advertising purposes. Apparatus, preparation of the subject, lighting and position, focusing, exposure, copying, X-ray or ghost photographs, development and printing are discussed. A valuable article for manufacturers and others using photographs to advertise their wares.

New Refuse Destructor for West New Brighton, Borough of Richmond, New York City. Eng. News, Nov. 5, 1908; 3 pp.

Reprint of a report by J. T. Fetherston, describing general construction and giving results of official acceptance tests of this refuse burning plant. General drawings are given of destructors and destructor building and diagrams of monthly variations in weight of refuse and seasonal variations in calorific power.

Cost of Building a Wire Fence. Eng.-Contr., Nov. 25, 1908; 1/2 p.

Gives cost of building 6,650 ft. of 4-wire fence.

Commissions for Constructing Public Works. By Horace Andrews. Mun. Eng. Mag., November, 1908; 3 pp.

The article discusses the question of whether the construction of municipal works can best be cared for by concentrating the responsibility in a Board of Public Works or in a single commissioner. The matter is taken from a committee report of the American Society of Municipal Improvements.

Cost of Building a Wire Fence. Eng.-Contr., Nov. 11, 1908; 1-5 p.

Gives costs of constructing 4-strand barbed wire fence.

Scows for Breakwater Construction. Eng. Rec., Nov. 21, 1908; 1/2 p.

A description of scows used to build a breakwater, equipped to dump large boxes of stone, carried above the deck of the scow. About 150 tons of stone can be dumped in 30 minutes.

The Testing Laboratory of the Bureau of Sewers, Brooklyn, and Some Tests of Sewer Pipe. Eng. Rec., Nov. 21, 1908; 3 pp.

The methods of testing sewer pipe and some results of the tests made are given. The tests made are for an external compression, an internal hydrostatic pressure, for impact and absorption.

Drilling Holes in Brickwork With a Machine Drill. Eng.-Contr., Nov. 4, 1908; 1/2 p.

Describes briefly results of drilling holes in brickwork with machine drills. After penetrating 8 to 10 ins. the drills wedged and could not be used.

The Present Status of Military Aeronautics. By George O. Squier. Jour. Am. Soc. M. E., December, 1908; 74 pp.

The author of this paper is a major in the signal corps of the U. S. Army. He tells of the progress that has been made in aeronautics and the present state of affairs in this country, England and Germany. Tells of the balloon plant at Fort Omaha, and gives the general consideration that govern the design of a dirigible balloon. Various types of machines are described and their management in the air is commented upon. The paper is well illustrated and a bibliography is given of aeronautics. Also the U. S. Government specification for areoplanes and dirigible balloons.

BOOK REVIEWS.

Electric Motors—Their Installation, Control, Operation and Maintenance.—By Norman G. Meade. New York: McGraw Publishing Co. Cloth. 4 1/2 x 7 1/2 ins.; pp. 159; illustrated; \$1.

This is a book for the works superintendent and the owner rather than for the electrical expert if we interpret the purpose of the author correctly. All mathematics are eliminated and the text is couched in plain terms and so illustrated by diagrams and drawings that persons having a very

moderate knowledge of electric phenomena can comprehend the statements made. As a manual for the works superintendent the book should find favor; it is essentially practical. Beginning with the theory of electric motors the author discusses in succession classification of motors, control and auxiliary apparatus, motor-generator sets, installation, operation, and repairs. Chapters VI and VII on operation and repairs are particularly useful, but the whole book is rich with hints and suggestions.

The Design of Highway Bridges and the Calculation of Stresses in Bridge Trusses.—By Milo S. Ketchum, M. Am. Soc. C. E. The Engineering News Publishing Co., New York. Cloth; 6x9 ins.; pp. 544. Illustrated; \$1.

Highway bridge design has been somewhat neglected by book writers in comparison with railway bridge design. The reasons for this are more evident than they are sound, and it is with particular pleasure that we welcome Professor Ketchum's excellent work. The reputation for practical book writing established by the author in "The Design of Steel Mill Buildings" and "The Design of Walls, Bins and Grain Elevators" is upheld by his most recent book. In this volume we have an entirely modern treatise on highway bridge design; it is a complete treatise at least in the sense that the whole bridge—substructure as well as superstructure—is considered, and that reinforced concrete, timber and masonry, as well as steel, are recognized as highway bridge materials. Culvert design and construction are also fully presented. Altogether we do not know where highway bridge designers can find elsewhere so much and such good practical information as is given them in this book. In places, perhaps, it may appear to some to have too much in mind the training of the student in bridge design and too little the needs of the experienced designer, but on the whole this is no great fault even when looked at from the viewpoint farthest from that of the class room. Professor Ketchum's book is a useful and needed addition to the literature of bridge design.

The book is divided into three parts, the first part containing nine chapters relating wholly to stresses in steel bridges. After a chapter defining and illustrating types of steel bridges the author takes up in order the resolution of forces, loads and weights on highway bridges, stresses in beams, in highway trusses, in railway trusses, in lateral systems and in details. Both graphical and algebraic determinations of stresses are explained in each case. The chapter on weights and loads is particularly good, numerous tables and diagrams being given for determining weights for various span lengths and forms of girders. In Chapter IX the author gives 24 problems in bridge stresses for solution. In fact there are 48 problems, each of the 24 so-called problems giving one problem fully worked out as an example and a second similar problem to be solved by the student. All but four of these problems are new and for the student at least they constitute one of the most practically valuable features of the book.

The design proper of highway bridges is discussed in eleven chapters comprising Part II of the book. The first five chapters treat wholly of steel bridge superstructure, viz., short span beam and low truss bridges, high truss bridges, both riveted and pin-connected, plate girder bridges, design of truss members, and details such as floors, railings, etc. This section or part is elaborately illustrated with dimensioned drawings. Chapter XV treats of the design of abutments and piers in masonry and reinforced concrete and of steel tubes. Then follow chapters on stresses in solid masonry arches, design of masonry bridges and culverts and the design of timber and combi-

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nation bridges. In the design of masonry bridges and culverts the theory of reinforced concrete is discussed. Chapter XIX is devoted to erection and estimates of weights and costs of highway bridges. This discussion of weights and costs is supplemented by an example giving in full the calculations of these items for a 160-foot span Pratt truss. Chapter XXII gives in detail the investigation of the efficiencies of the members of a 160-ft. span pin-connected highway bridge. The book closes with a set of general specifications for steel highway bridges drawn by the author. There are also many extracts from standard specifications scattered through the book.

Bridge Engineering—Roof Trusses. — A Manual of Practical Instruction in the Calculation and Design of Steel Truss and Girder Bridges for Railroads and Highways, Including Also the Analysis and Design of Roof Trusses and Other Details of Mill Building Construction. By Frank O. Dufour, C. E., Assistant Professor of Structural Engineering, University of Illinois. American School of Correspondence, Chicago. Half leather; 6½x9½ ins.; pp. 254 and 96; illustrated.

This volume is made up of the two sections on Bridge Engineering and Roof Trusses, respectively, contributed to the "Cyclopedia of Civil Engineering" reviewed in the Monthly Review Index for Sept. 2, 1908. The text has been "lifted" bodily from the larger work, preserving the separate paging. Keeping in mind its purposes and limitations, the Cyclopedia is a creditable piece of work, and Professor Dufour's two sections on Bridge Engineering and on Roof Trusses are among the best of the several contributions. The book will not take the place of the standard works of DuBois, Johnson, Ketchum, and others, but it does give a simple, clear discussion of its subjects for the student and particularly for the correspondence school student.

Smoley's Tables. — Parallel Tables of Logarithms and Squares, Angles and Logarithmic Functions Corresponding to Given Bevels, Together with a Complete Set of Five-Decimal Logarithmic-Trigonometrical Tables, for Engineers and Architects. By Constantine Smoley, C. E. Engineering News Publishing Co., New York. Flexible leather. 4½x7 ins.; pp. 458; illustrated; \$3.50.

The present fifth edition of this well known book of tables has been enlarged by the addition of a multiplication table for rivet spacing and tables of: (1) Common logarithms of numbers from 0 to 10,000, with tables of proportional parts; (2) Logarithms of the same and tangent from 0° to 3° and of the cosine and cotangent from 87° to 90°, varying by 10 seconds, with proportional parts for single seconds; (3) Logarithms of the sine, tangent, cotangent and cosine for each minute of quadrant with proportional parts for seconds; (4) Natural functions. The additions enlarge the usefulness of the book and will be appreciated by engineers.

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Acid Wash Finish For Cement Walks.

An acid wash finish for cement walks has been used during the last few years by the engineers of the South Park Commission of Chicago. Its success has been such that it has become by practice the standard sidewalk finish in all work done by the Commission. Briefly described, any time after the surface mortar has set, the top of the walk is flushed with a solution of muriatic acid which after it has "worked" sufficiently, is washed off by flushing with pure water. The acid wash etches the cement away between the particles of grit forming the remainder of the surface mortar and leaves this grit partly exposed. The object of the etching is merely to lay the grit bare by taking off the skin coat of cement produced by troweling; the cement is not eaten away deep enough to loosen the grit or to leave it projecting roughly. The result is a walk whose surface is relieved of all glare, shows no hair cracks, and is neither slippery nor rough.

We have made these comments largely in view of the criticisms urged against this method of sidewalk finish by our esteemed contemporary the "Engineering News" in its issue of Dec. 3, 1908. The method is criticised on three points by the News. First because of its assumed great cost, second because of the possible injury by the acid to the future growth of the grass along the walk, and, third, because "if it is desirable to roughen the surface of a concrete walk * * * it would seem better to sprinkle the surface with coarse sand or quarry dust after the floating is done and before the cement has set."

In another column of this issue we give in detail the cost of 3,466 ft. of 25-ft. cement walk recently constructed by the Chicago South Park Commission on Michigan avenue facing Grant Park. The cost of materials and labor for the acid wash finish of 29,395 sq. ft. of this walk was 1½ cts. per sq. ft. The washing was done by day labor by the forces of the South Park Commission and labor amounted to about two-thirds of the total of 1½ cts. per sq. ft. Under less rigid requirements as to quality of finish than were held necessary in this very prominent piece of walk and by contract work it is quite certain that the labor item could be materially reduced. But even a cost of 1½ cts. per sq. ft. for the excellent quality of finish given by the acid wash treatment cannot be considered, as the "Engineering News" thinks, "as involving such expense that it could hardly be recommended for general use."

Regarding the nature of the acid wash finish our New York contemporary is also in error. Sprinkling the unset surface mortar with coarse sand or quarry dust does not "give exactly the same result of a projecting aggregate as the acid treatment." The difference can be best defined perhaps as the difference between the surface of a good grindstone and the surface

of a piece of sand paper, the grindstone surface being that given by the acid wash and the sand paper surface that given by sprinkling with sand. No great perspicuity is necessary to see which of the two is the better surface for a cement walk. The editors of this journal have built a considerable number of cement walks and have studied the construction of a great many more than they have built and they have never seen such uniformly excellent results in surface finish as has been obtained in the many miles of park and boulevard walks built by the Chicago South Park Commission and finished by the acid wash process. As to the injury to future growth of grass by the dilute acid slop washed from the treated walk, we can only say that it has caused no distress to the Chicago South Park's authorities.

The Blackwell's Island Bridge.

In our issue of Nov. 25 we published an editorial on the Blackwell's Island Bridge, commenting upon the form of contract and the specifications, the condition of the bridge as shown by the reports of the experts, Messrs. Boller and Hodge and Prof. Burr (see ENGINEERING-CONTRACTING Nov. 18), and the responsibility for these conditions. We also asked that this whole matter be investigated by a board of engineers reporting to some city officials, other than the Bridge Department. Up to date we have not heard of such an investigating board being appointed.

We also quote from the contract showing that the detail and working drawings were prepared by the contractor, subject to the approval of the Bridge Department, and also that the contractor was to build a bridge according to contract, specifications and plans furnished to the contractor and to the satisfaction of the Commissioner of Bridges and his engineer.

We find that some of the statements contained in our issue of Nov. 25, 1908, in reference to the contract for the construction of Blackwell's Island Bridge, New York City, may be misleading as to the responsibility of the contractor. A careful investigation discloses the fact that the work was let under circumstances that made the contractor responsible only for the carrying out of the instructions of the Department of Bridges of the City of New York, the designs and strain sheets having been furnished to the contractor by the city.

The reports of the consulting engineers, Prof. W. H. Burr and Messrs. Boller and Hodge both indicate clearly that they paid particular attention to the quality of materials furnished, the character of the workmanship and the design of the details, as well as the accuracy of shipped weights, and that in every respect they found that the contractor had complied fully with the requirements. We wish to set forth these facts clearly in order to correct any opposite impression which may have been created by the article above referred to.

We believe that the designing and building of the Blackwell's Island Bridge should be investigated by a board of engineers, and this board could also see that the Manhattan Bridge will carry the load it is expected to carry, before it is too late to make radical changes in it.

Elsewhere in this issue we print two extracts from a discussion of the Technical League on this bridge. In these extracts attention is called to the method of considering the congested loading of the traffic on the bridge. This is one of the points in dispute among those responsible for the bridge and the expert engineers who reported on it. Attention is also called to the allowable stresses and strains in the steel and the general design as originally made by the Bridge Department and upon which bids were submitted by the various bridge building concerns. We believe these discussions will throw additional light on the subject.

The City Council of Chicago, Ill., has awarded the contract for the general work for the construction of the new city hall to the Noel Construction Co., Baltimore, Md., at \$3,295,000. A comparison of the cost of the new city hall on the basis of the accepted bid with the cost of the recently completed Cook County building shows the following:

	County.	City.
General work	\$3,469,358.42	\$3,295,000
Marble	390,911.00	471,000
Boilers, etc.	26,030.00	27,250
Switchboard ..	11,664.00	5,409
Coal and ash machinery	12,625.40	11,586
Generators .....	.....	14,245
Grates and furnaces.	6,503.90	6,210
Elevators	107,263.94	96,246
Pumps, tanks, etc.	23,773.05	21,185
Refrigerating plant .	2,675.00	6,975
Engines .....	.....	30,164
Pneumatic tubes ...	3,255.00	1,795
Fixed furniture ...	114,453.76	.....

Total	\$4,168,513.47	\$3,987,065
Wrecking and caissons	345,790.78	323,975

Total to date.....\$4,514,304.25 \$4,311,040

The amount of the item on fixed furniture is included in the city general bid.

Land has been set aside in Florida for the first National Forest east of the Mississippi River. The tract has been named the Ocala National Forest. It is located in Marion County in the eastern part of Florida and has an area of 201,480 acres, of which about one-fourth has been taken up under various land laws. It covers a plateau between the St. John's and Ochlawaha Rivers and at no point is an elevation exceeding 150 ft. above sea level obtained.

The Pennsylvania R. R. has decided to treat with creosote all ties that are to be used in its main tracks.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Methods and Costs of Constructing of Three Wooden Highway Bridges With Concrete Abutments In Cuba.

BY CHARLES MCKERCHER.*

The bridges were 5 meters or 16.4 ft. long and were constructed of Acana (see article on cost of highway bridge in ENGINEERING-CONTRACTING for Nov. 11th, 1908), a Cuban hardwood which abounds plentifully in the district where the bridges were constructed.

The structures, three in number, were built under the supervision of the writer in the winter and spring of 1907-08. They were all of the same class and their form and dimensions are shown in the accompanying drawings. All dimensions are in meters and decimals except timber sizes, which are in inches.

The cement used was Atlas Portland, which cost \$4.50 per bbl. placed on the work. The concrete was a wet mixture of

concrete and excavation. The costs of the three structures were as follows:

Bridge No. 1:

22 cu. yds. common excavation for abutments at \$0.612 = \$13.47.

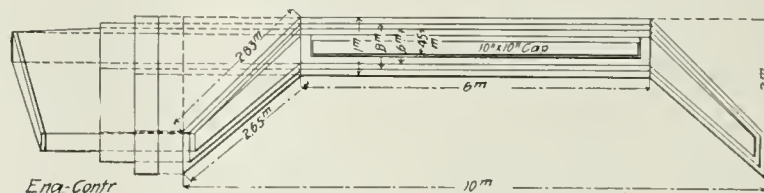
Concrete and forms.	Cost.	cu. yd.
31.5 cu. yds., 1-3-5 concrete	\$234.86	\$7.456
Lumber for forms.....	1.50	.047
Labor on forms, 1 carpenter 2.4 days at \$2.50.....	6.00	.190
Mixing and placing 31.5 cu. yds. of concrete.....	34.46	1.094

Total\$276.82 \$3.787

Bridge Proper: Total.

3,100 ft. B. M. Acana at \$50 per M.	\$155.00
Labor, framing and erecting, 6.8 days at \$4.25	28.90
130 lbs., bolts, spikes, plates, etc., at \$0.16 per lb.....	20.80
Painting	75.00

Total\$297.70



Plan of Concrete Abutment.

1-3-5, mixed by hand and well spaded and tamped in place. The cost of materials per cu. yd. of concrete was as follows:

1.13 bbls. of Atlas Portland cement at \$4.50 per bbl.....	\$5.08
0.80 cu. yds. of crushed rock at \$2.85 per cu. yd.	2.28
0.48 cu. yds. of river sand at \$0.20 per cu. yd.	.096

Total\$7.456

The lumber for the forms (250 ft. B. M., at \$18 per M.) cost \$4.50 and was divided between the three structures, making a charge of \$1.50 against each job.

The small amount of excavation does not indicate that solid rock was encountered near the surface, but as the foundation soil was firm only a sufficient amount was excavated to secure a foothold for the abutments. The master carpenter was paid \$2.50 per day and his assistants at the rate of \$1.75 per day. The charge for superintendence includes, inspection, laying out of work, and the foreman's time on the

Summary:

Excavation	\$ 13.47
Concrete	276.82
Bridge	279.70
Superintendence	51.55

Total\$621.54

Cost per lineal meter\$124.31

Cost per lineal foot..... 37.90

Bridge No. 2:

19.8 cu. yds. common excavation for abutments at \$0.65 = \$12.87.

Concrete and forms:	Cost.	cu. yd.
24.5 cu. yds., 1-3-5 concrete	\$183.67	\$7.456
Lumber for forms	1.50	.061
Labor on forms, 1 carpenter 2 days at \$2.50.....	5.00	.204
Mixing and placing 24.5 cu. yds. concrete	28.10	1.147

Total\$217.27 \$8.868

Bridge Proper:

3,100 ft. B. M. Acana at \$50 per M.	\$155.00
Labor, framing and erecting, 7.4 days at \$4.25.....	31.45

* Apartado No. 7, Neuviitas, Cuba.

130 lbs. bolts, spikes, plates, etc., at \$0.16 per lb.....	20.80
Painting	75.00

Total	\$282.25
Summary:	
Excavation	\$ 12.87
Concrete	217.27
Bridge	282.25
Superintendence	46.90

Total	\$559.29
Cost per lineal meter	\$111.86
Cost per lineal foot.....	34.10
Bridge No. 3:	
20 cu. yds. common excavation for abutments at \$0.587.....	\$11.74
Concrete and Forms:	

Total Per cu. yd.	
27 cu. yds. 1-3-5 concrete..	\$201.31 \$7.456
Lumber for forms.....	1.50 .055
Labor on forms, 1 carpenter 2 days at \$2.50.....	5.00 .185
Mixing and placing 27 cu. yds. of concrete.....	30.40 1.126

Total	\$238.21 \$8.822
Bridge Proper:	
3,100 ft B. M. Acana, at \$50 per M..	\$155.00
Labor framing and erecting, 7.6 days at \$4.25	32.30
130 lbs. bolts, spikes, plates, etc., at \$0.16 per lb.....	20.80
Painting	75.00

Total	\$283.10
Summary:	
Excavation	\$ 11.74
Concrete	238.21
Bridge	283.10
Superintendence	42.85

Total	\$575.90
Cost per lineal meter.....	\$115.18
Cost per lineal foot.....	35.12
Cost of 31.5 cu. yds. concrete in Bridge No. 1.....	\$275.82
Cost of 24.5 cu. yds. concrete in Bridge No. 2.....	217.27
Cost of 27.0 cu. yds. concrete in Bridge No. 3.....	238.21

Total cost of 83 cu. yds of con- crete	\$732.30
Average cost of 1 cu. yd. of con- crete	8.823
Total cost of Bridge No. 1.....	\$ 621.54
Total cost of Bridge No. 2.....	559.29
Total cost of Bridge No. 3.....	575.90

Total cost of three structures..	\$1,756.73
Average cost	585.57
Average cost per lineal meter.....	117.11
Average cost per lineal foot.....	35.70

A bill will be introduced at the next session of the Indiana legislature providing that plans for all proposed sewers and water works in Indiana shall be submitted to the State Board of Health for inspection.

Tests Showing Loss by Solution of Cement in Concrete Drain Tile.

BY A. O. ANDERSON.*

In referring to the question of the failure of concrete through the solution of its Portland cement bond, I submit the results of a few tests which were carried out in an investigation of this subject. As the series is not as yet completed, only a few results will be given which show quite striking features.

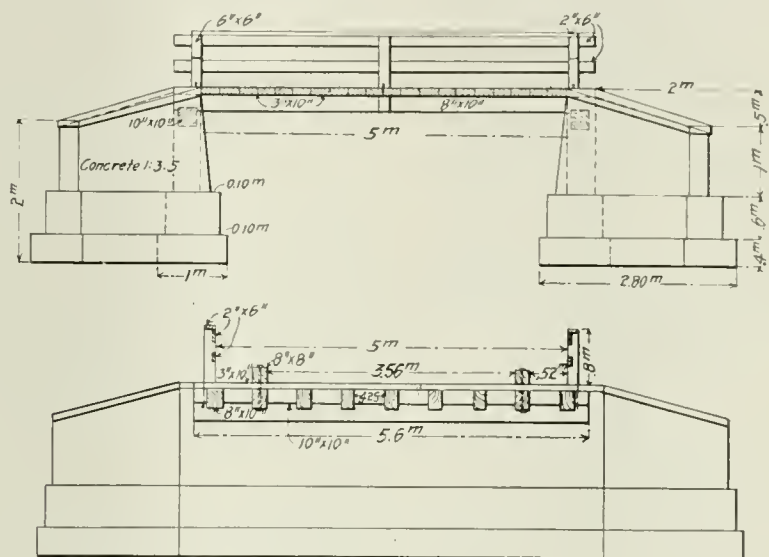
Specimens from drain tile of various ages were thoroughly dried, brushed with a stiff bristle brush to remove all loose particles, weighed and then placed in boiling water which was changed at intervals of one hour during the test. After being boiled for different periods, the specimens were dried, weighed and then replaced in water again for a longer interval of time. As the test pieces were subjected

A3.	23.422	23.480	23.520	23.688
A5.	28.605	28.516	28.685	28.955
A7.	33.815	33.855	33.997	34.030

A2 and A3 are from 20 in., and A5 and A7 from 18 in. cement drain which have been installed about four years.

An examination of these results will show that at the end of the first hour's boil, the decrease, if any, occurs and upon further boiling the weight actually increases. From the composition of "market" Portland cement, the results obtained are such as may be expected, for this material is a mixture of Portland cement and a retarder, both being ground to particles of varying size.

The retarder being gypsum, or a similar substance, is quite soluble and with the free lime or cement which may be soluble accounts for the loss that takes place during the early stages of boiling. As the tile



Eng. Contr

Form and Dimensions of Wooden Highway Bridge.

to the mechanical as well as the chemical action of boiling water, a loss from abrasion as well as from solution may occur. Results from two different series of tests are herewith given:

SERIES I.

No.	Original dry wght.	Wght. after boiling 1 hr.	Wghts. after boiling 7 hrs.
16	75.450 g.	74.780 g.	75.260 g.
24	53.320 g.	53.112 g.	53.305 g.

No. 16 is from a 16-in. cement tile; age about 60 days; mixture 1 to 3½, new.

No. 24 is from 24-in. cement tile; age about two years; mixture 1 to 1. This tile has laid along line of ditch for about two years.

SERIES II.

No.	Original dry wt.	Wt. after boiling 1 hr.	Wt. after boiling 5 hrs.	Wt. after boiling 15 hrs.
A2.	27,800 g.	27,604 g.	27,865 g.	27,860 g.

*Secretary Des Moines & Stoupe City R. R., Lake City, Iowa.

from which, the specimens in Series I were taken, are comparatively new and had not been subject to the action of percolating water, a larger decrease in weight is obtained than from those used in Series II, which have been used for drainage purposes for several years and probably had lost the greater part of their soluble components.

The increase in weight which is secured upon prolonged boiling may be due to the variation in size of grains in Portland cement. The rapidity of chemical action is dependent upon temperature and size of grain, the time and moisture being constant. As but half of "market" cement is supposed to be ground fine enough to possess settling qualities under normal conditions, the remainder will probably hydrate if kept in contact with moisture for a sufficient length of time or if subjected to a high temperature for a shorter interval of time. The specimens being subjected to the hot water, it is probable that many particles hydrated which because of their size

are not able to take up water and set under normal conditions. Whether or no this retarded setting results in an increase in strength of concrete can be determined by a series of tensile and crushing tests upon specimens which have been subjected to water at a high temperature. The specimens subjected to the tests outlined show no signs of disintegration.

These tests tend to show the advisability of using great care in securing the conditions most favorable to the setting of the maximum amount of Portland cement at the time of its manufacture into concrete. But little dependence upon retarded setting for increase in strength, should be placed as this is a doubtful factor, the tests in Series II, illustrating that even after four years exposure to moisture there is considerable material in the concrete that has not completely hydrated. These experiments may also point towards the advisability of using steam and water at higher temperatures for mixing and curing of concrete, thereby increasing the amount of useful bonding material in "market" Portland cement.

The experiments cited throw but little light on the subject of the solubility of Portland cement, as the increase in weight obtained results from the difference between the loss due to solution and abrasion and the gain due to hydration. As none of the tests were carried to the point where hydration was completed, no loss in weight could be determined.

The Secretary of the Treasury on Dec. 7 transmitted to congress the book of estimates of appropriations required for the services for the fiscal year ending June 30, 1910. The following shows by departments the estimates for the fiscal year 1910 and the appropriations for the fiscal year 1909, the latter including the deficiency, miscellaneous and permanent annual appropriations:

	Estimates for 1910.	Appropriations for 1909.
Objects—		
Legislative	\$ 13,178,178	\$ 14,124,586
Executive	415,510	440,510
State department.	4,320,395	4,413,469
Treasury department	190,896,645	235,000,675
War department.	234,093,150	193,328,116
Navy department.	137,510,388	133,160,401
Interior department	200,532,151	212,390,715
Postoffice department	1,711,010	1,737,450
Department of agriculture	18,817,626	15,786,219
Department of commerce and labor	13,013,815	11,311,105
Department of justice	9,890,020	10,003,087
Totals	\$821,408,918	\$832,629,393

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Operating and Maintaining an Electric Air Drill and Some Suggestions as to the Advantages of This Type of Drill for Trench Work.

We are indebted to Mr. W. L. McLaughlin, general manager of the Mogul Mining Co., of Deadwood, South Dakota, for the following information regarding the working of an Ingersoll-Temple electric air drill, made by Ingersoll-Rand Co., New York. For a description of this drill, which is not an electric drill, but an electric air drill, see ENGINEERING-CONTRACTING, May 27, 1908, p. 318.

The electric air drill consists of an electric motor that runs an air pulsator, which furnishes air to the drill, which is mounted either on a tripod or column. The drill strikes a very powerful blow, and, for this reason, the bits are blunter or thicker to avoid breakage. The drill used by the Mogul Mining Co. was a No. 4D. For this type of machine a 4 H.P. motor is used. The drill cylinder is 4¾ ins. in diameter. The length of the stroke is 7 ins. The machine is adapted to drilling vertical holes to a depth of 10 ft. Its work will compare favorably with a 2¾ in. diameter steam or air drill.

During the month of June, 1908, the Mogul Mining Company used this drill for cross cutting work in their mine. During the month the drill was worked for 99 hrs. After the first 20 days work a new man was put to running the machine, with the result that for 3 or 4 days less work was done by the machine, but after that he was able to operate it at the average of the drilling record. In all, 555 lin. ft. of hole were drilled. This gives a rate of 5.6 lin. ft. per hour.

The cost of operating the drill was as follows:

1 miner, 99 hrs., at 50 cts.....	\$19.50
1 helper, 99 hrs., at 25 cts.....	24.75
Total	\$74.25

A miner and his helper operated the machine. This gives a cost of 13.4 cts. per lin. ft. The cost for the power used is almost negligible, Mr. McLaughlin states, and for the conditions in their mine this machine effects a great saving over the drill run by the ordinary air compressor. The rock drilled was quite hard, and, considering the rates of wages paid, the cost is very reasonable.

The cost of maintaining the drill for the first 10 months was as follows:

New parts bought:	
6 springs	\$ 2.01
1 air gage	2.65
12 cup leathers	2.40
Fittings	10.25
Total	\$17.31
Labor	39.00

Grand total\$56.31

For the first two months no repairs were made to the drill. The average monthly cost of repairs to the drill was \$5.63. This makes a little over 1 ct. per lin. ft. of hole drilled during June, as a charge for drill maintenance. This is a low cost, especially when it is remembered that in comparing this cost with others, the cost of maintaining and repairing, the power plant needed for other style of drills, must be included.

City contractors always have an electric current available, and they should find the electric air drill especially adapted for drill purpose. It is still a common thing to find contractors for sewer and water pipe trenches doing all their rock drilling by hand. There is scarcely any class of rock work that requires so many lineal feet of drill hole per cubic yard as narrow trench work, yet, in the face of this fact, hand labor is extensively employed by city contractors. The principal reason for this adherence to hand drilling is found in the fact that the installation of a power plant and pipe lines, followed by the frequent shifting of the plant along the street, runs up the cost of steam drilling in narrow trench work to a point that is frequently above the cost of hand drilling. Then, too, there is often a lack of room in the street for installing the steam boiler, etc.

It seems to the editors of ENGINEERING-CONTRACTING that a drill of the type described in this article is admirably adapted for rock trench work, for the electric current can be tapped at intervals and a long coil of insulated wire be used to feed the small motor of the air pulsator that operates the drill. There is no cumbersome power plant to install and shift, and, instead of a heavy pipe line, there is simply a light line of wire that conveys the current.

The \$30,000,000 issue of Isthmian Canal bonds has been sold at an average of \$102.4368. The lowest accepted bid was at \$102.2778. There were 159 accepted bids amounting to \$30,000,000; 672 bids were rejected amounting to \$72,808,800. The total number of regular bids therefore was 831, subscribing for \$102,808,800.

Some Comments on Blasting in the Culebra Cut, and the Proposed Close Spacing of Drill Holes to Prevent Misfires.

An explosion occurred Oct. 8 in the Culebra cut on the Panama Canal, near Empire, in which five men were killed and eight men injured. The cause of this accident was thought to be a misfired hole, as a steam shovel was making a cut through some recently blasted material when the explosion occurred. It was thought that the dipper must have struck the cap or exploder of an unexploded charge.

This lamentable accident and a second, which is thought to have been caused by lightning striking the lead wire of a blast to be made at Mindi, have caused the officials on the Isthmus to urge great care in managing the work of blasting, so that such accidents will not occur. The "Canal Record" in describing a conference between the engineers of the Central Division and the steam shovel runners and the powder men at work in Culebra cut states:

"In addition to the precaution already taken, the commission has cabled for fifteen galvanometers, to be used in testing the fuses, and for 48 additional Star drills. The galvanometers, added to those already in use, will make the number 25 for the Central Division, and each powder man in the cut will be supplied with one. It will be his duty to test each fuse before it is placed in the dynamite cartridge; to test it after the hole is loaded; and finally, when wires have been strung to the battery, to test the circuit again in order to see that the current will enter the fuse. This will insure against defective fuses. In order to fire charges which may escape explosion when the current from the battery is turned on, holes will be drilled 12 ft. apart, after the arrival of the extra drills, instead of 20 ft., as is usual at present, and thus each hole will be so close to its neighbor that even though one of them should not explode when the current is applied, the detonation from the nearby hole will set off the charge of dynamite."

The testing of electrical exploders, both before and as they are being used, is an excellent method of detecting exploders in which the bridge is broken. The use of some kind of a galvanometer is certainly to be recommended to all users of explosives. There are on the market several of these instruments and some of them are made to be conveniently carried in either the coat or hip pocket, so that they are always on hand to be used. Their small cost is quickly repaid when they prevent the use of one poor exploder, as the time lost by the men leaving the work a second time, the time lost drawing the tamping in a deep hole and placing a new exploder, to say nothing of the inefficient blasting caused by a misfired hole when blasting in series, amount to much more than the price of one of these small instruments.

The decision, however, to space the drill

holes closer than the spacing now used, namely, 20 ft. reduced to about 12 ft., in order to prevent misfires, is to be condemned in no uncertain terms. In rare instances, if ever, will close spacing prevent misfires, whereas such close spacing will almost triple the cost of drilling per cubic yard of rock.

Indeed, the chance of accidents from misfires will be increased threefold by the very effort to reduce accidents from misfires, for there will be three times as many blast holes and three times as many exploders that may not explode.

With drill holes spaced 20 ft. apart, each lineal foot of drill hole breaks $20 \times 20 = 400$ cu. ft. of rock. With drill holes 12 ft. apart, each lineal foot of drill hole breaks only $12 \times 12 = 144$ cu. ft. of rock, or one-third as much as with the 20 ft. spacing. Therefore the cost of drilling will be tripled, and it will be found that a greater expense for explosives will be incurred.

If life saving could be accomplished, all this added expense would be justified, but not a single life can be saved, for the reasoning that has led to the proposed 12 ft. spacing of drill holes is erroneous.

The writer has had holes spaced much closer than 12 ft., where the character of the rock necessitated close spacing, yet the exploding of one blast did not set off another. In one instance he remembers holes about 10 ft. deep spaced 4 ft. apart, yet one hole misfired, owing to a defective exploder, and the charge was not detonated by the explosion of the two holes on either side of it. This is an example in open cut work. Every mining engineer and tunnel builder knows that, in blasting out mining tunnels and tunnel headings, holes are spaced very near together and that the holes are often fired in groups after all the holes are loaded, yet the exploding of one group of holes, although they are very close to another group, does not explode the second group. In tunnel work of this kind the holes are not always sprung, but in open cut work they are generally sprung, yet one hole will not explode another except by an accident.

This is especially so when dynamite is used. Seams and rifts of the rock are opened up by springing holes, and, if black powder is used, the grains in large numbers often enter these seams and rifts; but, when dynamite is used, seldom more than the chamber is filled. When black powder is used and when it enters old seams and rifts, there is a greater possibility that one hole will help to ignite another, but even then the chances are against it.

At Panama, however, the blasting is being done to a great extent with dynamite, for, during the past year, nearly 9,000,000 lbs. of dynamite have been bought, while only about 54,000 lbs. of black powder were bought.

The fact that well drilling machines are

being used to drill the blast holes would seem to indicate that large deep holes are drilled, then sprung and afterwards blasted. If the blasting is not being done in this manner it should be. Under these circumstances it is a waste of money to use dynamite except for springing. (We believe we are correct in stating that 10 and 60 per cent dynamite is being used in the canal blasting.) The most economical blasting that can be done for loosening such material, to be moved with steam shovels, is to spring the holes by dynamite, although at times either black powder or Judson will serve better for this purpose, especially if the hole is to be sprung a number of times, and to shoot the holes with either black powder or Judson.

Black powder should be used in very large blasts that are meant to throw down and out of position large quantities of material, while Judson is preferable when it is only meant to shake up and loosen smaller quantities, especially if the blast is to be made close to the shovel. Dynamite will be needed to break up the boulders that are thrown out, and there will be, as a rule, more boulders to break when black powder is used than when Judson powder is used.

Records of Driving Rock Tunnels and Some Comment on the High Cost of the Elizabeth Tunnel.

One of the daily papers of Los Angeles, Cal., states that the world's record for rock tunneling was broken on the Los Angeles aqueduct in October, when the force of workmen employed at Elizabeth Lake drove 466 ft. from the south portal.

The Elizabeth tunnel is to carry the waters of the Los Angeles aqueduct through the crest of the Coast Range, and is to be about 5 miles long. The section of the tunnel is 12x12 ft. The work is being done by day labor forces in bringing the Oricus River water, as an additional water supply, to Los Angeles. The entire project is estimated to cost about \$23,000,000.

The cost of driving this tunnel has been \$35.81 per lin. ft. according to published reports, and includes labor and materials, but does not include the lining of the tunnel. A bonus is being paid to the men for all work in excess of a given amount, and the above cost per lineal foot includes this bonus.

To those who are well informed on rock tunneling it is useless to state that 466 ft. from one portal is not the world's record for a month's driving, as on a number of tunnels in Europe much greater distances have been driven in a month. However, it does stand as the best month's record for work of this character in America, yet one record for a week's work on the New Croton Aqueduct tunnel of New York City.

was 127 ft., equivalent to a monthly rate of 550 ft.

In view of the interest that the Los Angeles work has aroused in rock tunnels we publish the following records made in various tunnels. The following are the records made per month in European tunnels of note:

Name of tunnel	Location	Max. progress of single heading in ft. per mo.
Mt. Cenis	Alps	297
St. Gothard	Alps	436
Ricken	Switzerland	461
Bosniak	Austrian Alps	546
Fauren	Austria	548
Karawanken	Austrian Alps	553
Loetschberg	Switzerland	574
Albula	Alps	607
Arlberg	Alps	641
Simplon	Alps	685½

The world's record has been made in driving the Simplon tunnel. In many of these tunnels, more than 500 lin. ft. of heading were driven during many months, and in some cases an entire year's work averaged over 500 lin. ft. All of these tunnels were driven with a bottom heading, except the St. Gothard, which was driven according to the American practice, with a top heading. Special attention is directed to the record of the Ricken tunnel, in which hand drilling alone was used. In the other nine tunnels, machine drills of different types were used.

The following records have been made on American tunnels.

Name of Tunnel	Location	Maximum progress of single heading in ft. per mo.	Method of Drilling	Kind of Tunnel
Musconetung	N. J.	144	Machine	R. R.
Nesquehoning	Penn.	165	"	R. R.
Hoosac	Mass.	184	"	R. R.
Busk	Colo.	202½	"	R. R.
Central	Colo.	222	Machine	Mining
New House	Colo.	244	"	"
Hot Time Lateral	Colo.	260	"	"
Stampede	Wash.	274	"	R. R.
Cascade	"	301	"	R. R.
Aspen	Wyo.	306	"	R. R.
Melones	Cal.	307	"	Mining
Bitter Root Mt.	Mont.	333	"	R. R.
Niagara Falls	"	"	"	"
Power Co.	N. Y.	338	"	Power
Ke'logg	Idaho	354	"	Mining
Ophelia	Calo.	359	"	"
Raton	"	395	"	"
Sutro	Nev.	412	Augers	R. R.
Gunnison	Colo.	449	Machine	Drainage
Elizabeth	Cal.	466	"	Irrigation
New Croton Aqueduct	N. Y.	550	"	W. Works

The Elizabeth tunnel holds the record for a month's work, as the New Croton Aqueduct tunnel's record is estimated from their best week's run of 127 ft. It is included in this list as this week's record seems to be best work done in an American tunnel that has appeared in print.

The record in the Elizabeth tunnel at Los Angeles was made in 3 shifts of 8 hrs. each. The record at Ouray, Colo., of 359 ft., was made in two 8-hr. shifts. The other records were made either in three 8-hr. shifts or two 10-hr. shifts.

The records given are for the complete tunnel, where the section is small, and

only for the heading when the section is large, as in the railroad tunnels, and for work done in one heading only. In many cases the average month's record nearly equaled the best month's work.

The following table gives the cost of the work in six of these tunnels:

Name of tunnel.	Location.	Maximum of single ing in ft.	progress head- per mo.	Size ft.	Cu. yds. per lin. ft.	Cost per lin. ft.	Cost per cu. yd.
New Anese	Colo.	244		12x12	5.34	\$21.45	\$1.02
Melones Mines	Cal.	307		7x8	2.07	11.02	5.32
New Croton Aqueduct....	N. Y.	550		10x14	5.20	27.66	5.32
Ouray	Colo.	359		7½x7½	2.08	12.02	5.87
Elizabeth	Cal.	466		12x12	5.33	36.81	6.90
Hot Time Lateral.....	Colo.	260		5x7½	1.40	13.50	9.64

All of these tunnels, with the exception of the New Croton Aqueduct tunnel, are located in the southwest, but this tunnel is given as it has nearly the same area in cross section as the Elizabeth tunnel. A glance at this table shows the exceedingly high cost of the Elizabeth tunnel. Five of these six tunnels are built under somewhat similar conditions as to labor, character of the rock and location in an arid country with poor facilities for transportation, yet only one tunnel, the Hot Time Lateral, cost more than the Elizabeth tunnel, and it will be noticed that the area of its cross section is less than half that of the Elizabeth tunnel. This feature alone would add considerably to its cost per cubic yard, but, in addition, economy was sacrificed for speed, and men were worked in this small tunnel to a disadvantage in order to hurry the work. It, too, was done by the day labor system.

It will be noticed that the New House tunnel is the same size as the Elizabeth tunnel. The New House tunnel, as well as the New Croton Aqueduct, was done by contract, and a comparison of the cost per cubic yard for the rock excavation shows the high price the city of Los Angeles is paying for doing this important work by day labor, in spite of the fact that it is unusually well managed for a day labor job.

The New House tunnel resembles the Elizabeth tunnel in many respects. Both are about 5 miles long, and both of the same size, and we believe both tunnels are through porphyry rock. The cost given for the New House tunnel is the average for the entire work, while the Elizabeth tunnel is for the best month's work in one end, and when the haul on the excavated material is short. In both of these tunnels Water Leyner rock drills have been used. In the Elizabeth tunnel the drills are of the Model 6A type. The cost of the Elizabeth tunnel is already 70 per cent greater than that of the New House, and when it pierces the mountain to a greater depth the cost will, no doubt, increase.

The bonus paid the workmen in the Elizabeth tunnel does not add to the cost, as Mr. J. B. Lippincott, Assistant Chief

Engineer of the Los Angeles Aqueduct in commenting on this work in Engineering News states:

"The base rate on the bonus system employed is 8 ft. per day, or 248 ft. for a 31 day month. For each foot in excess of

this amount each man working in the tunnel continuously during the month is paid 40 cts. As the cost per day for driving the tunnel is practically a fixed amount, the faster the work is driven the less the cost per ft. becomes. [Also the less the cost per cu. yd.—Editors]. The saving to the city in fast work is shared with the men by this means."

The cost for this Elizabeth tunnel work, in comparison with other jobs in the southwest, is high, although the rock work on the Gunnison tunnel, which is being done by the Reclamation service by the day labor system is costing more, but the heading is smaller, namely, 8x12.

Contract work is being done more cheaply, and we have no doubt that, if the city of Los Angeles will change their method from the day labor to the contract system, they will be greatly the gainers by the change.

The engineers estimated this tunnel work would cost \$66 per lin. ft. exclusive of lining. Upon what they based this high estimate we do not know unless it was on other day labor jobs. If the work is continued by day labor, this high estimated cost may ultimately be reached.

The Chicago Architectural Club, 84 Adams street, Chicago, Ill., is to hold an architectural prize competition on the design of a suburban concrete residence. Three prizes offered by the Universal Portland Cement Co. will be awarded as follows: \$200 for the best design, \$75 for the next best and \$25 for the third best. The competition is open only to persons residing within a radius of 50 miles from Chicago, and the drawings are to become the property of the company donating the prizes. The building is to be on a suburban lot, 100x250 ft., is to contain at least 8 rooms and two baths, must be constructed in foundations and walls, of concrete, plain, reinforced or in blocks, and in the floors of reinforced concrete. Further particulars of the competition may be obtained from the architectural club.

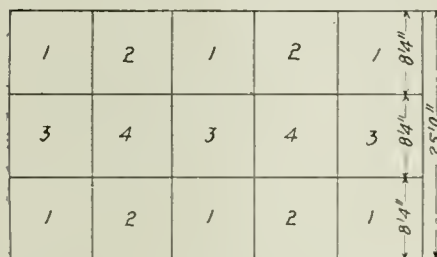
There are now 19 states and Alaska, having National Forests.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Cost of Constructing a 25-ft. Cement Sidewalk and Curbing on Michigan Avenue, Chicago, Ill.

The method of constructing a 25-ft. cement sidewalk on Michigan avenue, Chicago, using a machine mixer was briefly described in our issue of Oct. 28, 1908. The walk was constructed in alternate squares 8 ft. 4 ins., as indicated by the sketch, Fig. 1. In addition to the walk proper a curb was built as shown by Fig. 2. A 1-2-4 mixture was used for the base and a 1-2½



Eng. Contr.

Fig. 1.

granite screenings mixture was used for finish. The finish was floated into place with a straight edge and then troweled, and to remove the trowel marks and skin surface of cement, the surface was washed with an acid solution. The walk was built by day labor by the South Park Commission of Chicago and its cost is given by Mr. Linn White, Engineer South Park Commission as follows:

Labor—	
On walk	\$2,825.86
On curbing	376.34
	\$3,202.20
Material—	
240 Bags Lehigh Cement at \$0.43	\$ 103.20
1,020 Bags Atlas Cement, by wagon (bbl.) at \$1.55	307.80
10,940 Bags Atlas Cement, by car, at \$1.33	3,610.20
282 yds. granite, at \$3.70	1,043.40
108 yds. Torpedo sand at \$1.75, and 532 yds. Torpedo sand at \$1.65	1,066.80
1,261 7-10 yds. limestone	1,981.17
Miscellaneous material	66.63
14,307 ft. lumber for forms and strips	338.04
	\$8,607.24
Credit by Material Left Over or Used on Outside Labor.	
600 bags Atlas cement at \$0.33	\$198.00
8 yds. stone at \$1.65	13.20
4 yds. granite at \$3.70	14.80
Cost of material used on outside labor	59.02
12,200 cement bags returned at \$0.07½	1,200.02
	7,407.22
	\$10,609.42
Add 10 per cent for superintendence and tools	
	1,060.94
Total cost of concrete work	\$11,670.36
The area of the walk was 25x3,466 ft., or	

86,650 sq. ft. The cost per square foot was thus as follows:

	Per sq. ft. cts.
Labor	3.70
Cement	3.46
Material	4.70
Forms	0.39
Superintendence and tools	1.22

Total

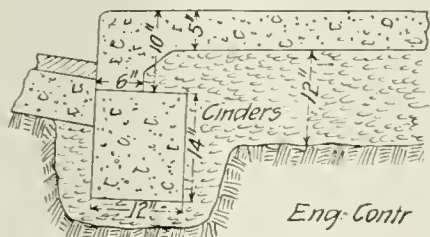
The cost of finishing the surface by acid wash was as follows:

Labor	\$289.75
Material:	
60 Carboys Muriatic acid 180 lbs. each. at	\$0.01¼ \$135.00
36 deck brushes at.. 0.50	18.00
Total material	\$153.00
	\$422.75

Add 10% for superintendence and tools

	44.27
Grand total	\$487.02

The cost of surface treatment for 29,395 sq. ft., per square foot of walk was there-



Eng. Contr.

Fig. 2.

fore 1½ cts. per sq. ft., which added to the cost of construction gives a total cost of 13.47 + 1.67 = 15.14 cts. per sq. ft. The cost of grading was \$4,104.05, including the removal of 8 ins. of soil and filling with cinders to a depth of 12 ins.

S. N. D. North, Director of the census, has asked an appropriation of not less than \$14,000,000 with which to take the 13th census in 1910. The cost of the last census, in 1900, exclusive of the four annual investigations and two biennial reports due the same year, was \$12,520,000. The Director estimates that the cost of the next census, due to the fact that he now has a regularly organized office, will be only \$410,000 more than the census of 1900.

A total of 134,240 tons of manganese, valued at \$986,660, was imported by the United States in nine months.

Bituminous Macadam Road Construction in Rhode Island and Specifications for the Work.

In an informal discussion of the subject of "The Maintenance of Macadam and Other Roads,"* at the annual convention of the American Society of Civil Engineers, June 25, 1908, Mr. Arthur H. Blanchard, Assistant Engineer State Board of Public Roads of Rhode Island, gave much valuable data on the treatment of roads with oil and tar.† The experiments from which these data were obtained were conducted by the Rhode Island Board of Public Roads in 1906, 1907 and 1908. Mr. Blanchard described the work done up to June, 1908, and in a closure of the discussion described the bituminous macadam road built since that date. The complete discussion has been reprinted by the Society and the matter in this article has been taken from the reprint.

The road treated was a section of an interstate trunk line in the Town of East Providence. It was built by the mixing method with the bituminous mixture omitted from the surface of the No. 1 course. In the construction of this work, which was 11,870 ft. in length, various bituminous mixtures were used to meet conditions as they arose. The grading required for the formation of the gravel subgrade was light, throughout the entire length of the road, varying from a cut of 5 in. to a fill of 7 in. The broken stone used was a mixture of chlorite gneiss and indurated sandstone.

From Station 0 to Station 1950 on the first mile, Providence gas-house tar was used as the binding material. Between the stations mentioned the grade varied from a minimum of 0.36 per cent to a maximum of 2.30 per cent. This section was constructed during June and July, the temperature varying from 55° to 95°, the average being 70° during working hours. The tar used was purchased from the Providence Gas Works, and cost at the works \$2.50 per barrel. The cost of the barrel per shipment of tar was \$0.08, based on the cost of cooping and depreciation, as the State Board purchased a large number of barrels at the opening of the construction season. Loading and hauling full barrels and reloading and hauling empty barrels a distance of five miles cost \$0.30 per barrel. The total cost of the tar, therefore, was \$2.88 per barrel. The mixing and spreading gang included two tar men at \$2.00 per day of 10 hours, and four common laborers at \$1.50 per day. The cost of the labor, including 15 per cent profit for the contractor, and based on an average rate of progress of 250 sq. yd. per day, was \$0.039 per sq. yd. The wages of one common laborer who would have been employed on the No. 2 course if an ordinary macadam road had been constructed, was deducted, as per agreement, from the labor cost. The cost

*Transactions American Society of Civil Engineers, Vol. LXXI, p. 445 (1908).

†See Engineering-Contracting, Oct. 7, 1908, for a description of this work.

of accessories, which included rent of kettles, etc., and cost of cord wood, was \$0.009 sq. yd. The cost of watering, to lay the dust on the car tracks adjacent to the road, was \$0.006 per sq. yd. The cost of the tar, at 1.25 gallons per sq. yd., was \$0.072. The rebate accruing, as per agreement, by not using a watering cart on the construction of the macadam surface, was \$0.001 per sq. yd. The total cost of the tar macadam, in excess of the cost of ordinary macadam, therefore, was \$0.122.

Although great care was exercised in watering, considerable dust, raised by car and other traffic on double tracks adjacent to the road, collected on the surface of the No. 2 course before it could be rolled and covered with screenings. The natural result was that the bond between the screenings and the No. 2 course was not as good as in the case of the tar macadam in Charlestown and Narragansett. As the East Providence road is subjected to a heavy motor-car traffic, and also to an unusually heavy horse-drawn vehicle traffic, it was decided, from the standpoint of insurance against disintegration, to seal the surface by painting the No. 2 course just before the application of the screenings. The result has been very satisfactory, and, it is believed, has justified the additional expense. The cost of tar, at 0.6 gallon per sq. yd., was \$0.035. One tar man at \$2.00 per day of 10 hours, and one common laborer at \$1.50 per day, constituted the force. As an average of 390 sq. yd. was painted per day, the cost of the labor, including 15 per cent profit for the contractor, was \$0.01 per sq. yd. The cost of accessories, including kettles, dippers, pails, brooms, and fuel, was \$0.001 per sq. yd. The total cost of painting with tar was \$0.049 per sq. yd. Hence the total cost of the tar macadam painted with tar, above the cost of ordinary macadam, was \$0.171 per sq. yd. The above form of construction was used from Station 1905 to Station 2350.

A short distance beyond Station 2350, the road was narrow, leaving room for only one car track, whereas, up to this point, double tracks on one side of the road carried the heavy car traffic to summer colonies and to three amusement resorts. When the road widened out again, at Station 3500, the traffic was carried by two tracks, one on each side of the road. As it was impossible to close the highway to motor and other traffic, it was evident, due to the above arrangement of tracks, that the bituminous macadam would be subjected to more or less traffic before it set up. Due to these conditions and to the fact that the asphalt-tar-macadam constructed as an experiment in Narragansett was giving excellent service, it was deemed advisable to adopt a bituminous binder of 50 per cent Texaco asphalt, Grade J, and 50 per cent tar, which would accelerate the setting of the bituminous macadam and permit rolling within 12 to 24 hours. The asphalt-tar-macadam was used from Station 2350

on the first mile to Station 400 on the second mile, and from Station 1625 to Station 3238 on the second mile. On these sections the grade varied from a minimum of 0.12 per cent to a maximum of 2.40 per cent. The work was done in July to October, the temperature varying from 31° to 89°, the average during working hours being about 60 degrees. The asphalt cost \$2.66 per package of 40 gallons at the Providence plant of the Texas Company. The cost of loading and hauling a distance of 5 miles was \$0.25 per package, making the total cost \$2.91. As the total amount of bituminous material used in the mixing was 1.25 gallons per sq. yd., and as 50 per cent of asphalt and 50 per cent of tar were used, the cost of the asphalt was \$0.046 per sq. yd., while the cost of the tar was \$0.036. The mixing and spreading gang included two tar men at \$2.00 per day of 10 hours, and five common laborers at \$1.50 per day. Due to the fact that asphalt is more difficult to handle and sets more quickly than tar, the rate of progress per day was slower, averaging 200 sq. yd. The cost of the labor, therefore, was \$0.058 per sq. yd. The cost of accessories was \$0.009, the cost of watering to allay the dust was \$0.006, and the rebate on watering was \$0.005 per sq. yd. The total excess cost of the asphalt-tar-macadam, without the surface coat, was \$0.15 per sq. yd. The complete excess cost, including the surface coat of 0.6 gallon of tar, was \$0.199 per sq. yd. As an experiment, the surface coat of tar was omitted for a section of 100 ft. Also, as an experiment, a section of about 200 ft. was painted with Texaco asphalt, Grade J, in place of tar. It was found that 0.6 gallon of asphalt would cover 1 sq. yd., hence, the cost of the bituminous material was \$0.044 per sq. yd. As the same number of yards were painted per day as when tar was used, the cost of labor, etc., was the same, the total cost, therefore, was \$0.058 per sq. yd., making the total cost of the asphalt-tar-macadam, painted with asphalt, \$0.208 per sq. yd.

The approach of cold weather necessitated another change in the bituminous material used. It was found to be practically impossible to coat the stone thoroughly, using asphalt and tar as described above. Due to this fact, and also because motor, horse-drawn vehicle, and car traffic had fallen off 50 per cent, it was decided to use tar as the bituminous material in mixing the No. 2 course, and Texaco asphalt, Grade H, for painting the surface. The cost of the tar-macadam, omitting the surface coat, was the same as described above, namely, \$0.122 per sq. yd. As the Grade H asphalt cost \$2.91 per package at the plant, and loading and hauling cost \$0.25 per package, the total cost was \$3.19 per package. The cost of 0.6 gallon used per square yard, therefore, was \$0.048, making the total cost of the painting \$0.062 per sq. yd. The total cost of the bituminous macadam, therefore, was \$0.184 per sq. yd.

From Station 400 to Station 1625 on the second mile, an experimental section was built, using Providence Gas-Works tar and Genasco Road-Compound Base, furnished, without expense to the Board, by the Barber Asphalt Paving Company. These materials were used in the proportion of 25 per cent Genasco Base and 75 per cent tar. The method of construction was similar to the methods already described, the surface being painted with tar.

Mr. Blanchard concludes that judging from experience acquired during the construction of bituminous macadam in Rhode Island in 1906, 1907 and 1908, it is apparent that the field of experimentation for the season of 1909 should include the development of economical mixing machinery, the determination of the economics and efficiency of heated stone, and more complete laboratory and field analyses of bituminous materials.

Since June, 1908, the bituminous macadam has been constructed in accordance with an agreement and specifications compiled by Mr. Henry B. Drowne and Mr. Blanchard. The contracts were awarded on the basis of the construction of an ordinary road in accordance with the standard specifications of the State Board of Public Roads.

The agreement with the contractor for extra work on account of the construction of bituminous macadam surface provides that the contractor shall do all the work and furnish all the material, except bituminous materials, and that the extra work directly connected with the laying of the bituminous macadam surface will be paid for on the basis of the actual labor cost plus 15 per cent. The agreement also provides that the contractor shall furnish tar-kettles, accessories, etc., and that payment be made for the use of such utensils on the basis of each kettle actually used when the bituminous surface is being spread.

The specifications for the bituminous macadam are as follows.

These specifications are supplementary to and an integral part of the Standard Specifications, of the State Board of Public Roads, for macadam roads, and in no way replace them, except in so far as the construction of the No. 2 course and finished surface is concerned.

Plant.—The roller used in rolling the bituminous macadam surface shall not weigh more than 10 tons.

The kettles shall be of such shape and size that they can be easily transported by hand from point to point. No kettle, however, shall be used that will not hold 2 barrels of tar, except by special permission of the engineer.

When mixing on the road, a mixing board shall be provided for each gang so engaged. The mixing board shall be made of 2-in. plank, 16 ft. long, in two sections each 4 ft. wide.

Bituminous Compounds.—Coal-tar shall be placed in the kettles so that the depth of

tar is not more than 18 in., unless otherwise directed by the engineer. Water in the tar shall be caught when the tar is being run into the kettle. If any rises to the surface of the tar in the kettle it shall be skimmed off. When tar is the only bituminous compound used, it shall be heated for 2 hours at a temperature between 150° and 180° Fah., then raised to at least 200° before using.

Kettles shall be placed so that hot tar will not have to be carried more than 50 ft.

In storing tar, barrels shall be laid on their sides with the bungs up.

Asphalt shall be placed in the kettles in such quantities as may be desired, and brought to a heat of 350° Fah. before using.

When the bituminous compound consists of tar and asphalt mixed half and half, the tar shall be heated in one kettle and the asphalt in another. The tar shall be brought to 200° Fah. before using; the asphalt to 350° Fah. before using. In mixing by hand the tar shall be placed on the stones before the asphalt.

Stone.—The No. 2 stone must be dry and free from dust. No No. 1 stone will be allowed in the No. 2 course.

No work shall be done when the No. 1 course is wet. The work shall not be resumed until the stone has dried out to the satisfaction of the inspector.

Mixing Bituminous Compound.—The bituminous compound shall be mixed with the stone either by hand or by machine until the stone is thoroughly coated to the satisfaction of the engineer or inspector. One and one-quarter gallons of bituminous compound shall be used per square yard of surface, unless otherwise directed by the engineer.

The No. 2 stone shall be laid to a thickness of 3 in. and rolled to 2 in.

The No. 2 course shall be rolled as directed by the engineer or inspector.

Painting.—After the surface has been thoroughly rolled and shaped up, to the satisfaction of the engineer or inspector, the surface shall be swept clean. The bituminous compound shall then be spread on the surface either by brooms or mops. Six-tenths of a gallon of the bituminous compound shall be used per square yard of surface, unless otherwise directed by the engineer.

Dust.—Dust screenings shall be perfectly dry.

Dust screenings shall be put on to a thickness not exceeding $\frac{1}{4}$ in., unless otherwise directed by the engineer or inspector.

No dust shall be put on until the surface has set to the satisfaction of the engineer or inspector.

When the surface is required to be painted, the dust screenings shall be put on immediately after the flush coat of bituminous compound has been applied.

The surface shall be rolled as directed by the engineer or inspector.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods and Costs of Making Wash Borings on a Ship Canal Survey.

BY A. W. SAUNDERS, C. E.*

The following data were obtained on a survey of 95 miles, covering the operations of a year. The line ran over a little rough country, two rivers and a lake. The land

into the office where the whole is plotted; the notes and samples are filed.

Figure 2 is the Sullivan earth drill. This view clearly shows the workings of both types. Water is forced through the drill rods down to the foot or "shoe" of the casing and then up in the casing bringing with it the material drilled through, a sample



Fig. 1—Carpenter Wash Drill—"Light Hammer."

was not "rocky," though there were some stony plots of course.

The equipment was complete in all its details, thus enabling an economic and thorough prosecution of the work, i. e., making test borings to locate the "rock line" or elevation of the rock in the earth, on a survey of a ship canal.

Two parallel lines were run 500 to 1,500 ft. to the right and left of the main line. This necessitated a systematic and constant hustle to prevent a stalling of the work, for one machine often was on one side of a river and others scattered over a mile of ground.

Figure 1 is the Carpenter wash drill. The pump is to the left and rear of the hammer. This machine, equipped for 120 ft. of work with pump, 500 ft. of 1½-in. water pipe and all necessary accessories, will now cost \$200. This machine is readily transported by hand through swamps, marshes or even rivers; and, with its tool box, shown on the left, makes but a small one-horse load. Two 2 oz. sample bottles are shown (just below the foreman's knee). The notes are recorded in his note book suitably ruled; samples of the borings are obtained, the bottles labeled and all sent

of which is thus obtained and its "condition" noted. This machine is not as easily moved as the other and trails along behind a wagon. It will now cost \$300 completely equipped for 100 ft. of work with 500 ft. of 1½-in. water pipe, pump, etc. A portable blacksmith or repair shop, 12x12x8 ft., equipped with pipe working tools, forge,



Fig. 2—Sullivan Drill.

*Johnstown, Pa.

The total amount of work in one year's

\$21,862.12

This includes its share of the expense

A Carpenter machine was used by the writer on the Wachusett Aqueduct, Massachusetts. I often obtained a sample of earth



Fig. 3—Carpenter Wash Drill—"Big Hammer."



Fig. 4—Pulling Pipe After Deep Drilling.

On another job in New York state, a carpenter, with some of my Massachusetts men, was 17 days on one hole, including lost time by reason of bad weather, breakages and 2 Sundays; 55 half-pound sticks of dynamite were used blasting and blowing boulders out of the way. This was an unusual condition, yet I quote it, as I had to meet it and overcome it. It figures in

[illegible][illegible][illegible]

with the cost. Incidentally I will say for the benefit of younger readers, the Chief showed up on this hole. I was delighted to see him. He left me fully convinced I had troubles of my own. Heretofore he had happened around when it was easy going and thought it all simple, swift and sure. It is a good thing to let the Chief see the difficulties, so don't worry if he does show up when things are roughing up. They will even up in time; for instance, the day after finishing this hard hole, this same crew moved their machine 1,000 ft. by hand, drove their pipe and obtained a sample of the rock at about 80 ft. below the surface, had their casing up and out on firm land ready for the team that night. I will add I was delighted to send that fact in too.

On water the machines are set up on rafts 17.5x24.5 ft. composed of timbers, planks and oil barrels and constructed so as to allow the raft to be moved away from the pipe should occasion require.

There need be but little time lost during the winter. Greater care is necessary, however, to prevent the pumps and pipes from freezing at night.

Comparing the working of the two types of machines, during one-quarter of the year (3 months), the Carpenter machine drove 21 holes to a total depth of 1,501.6 ft. at a total labor cost of \$760.35, explosives and freight \$22.69, which is equivalent to 52.1 ct. per ft.

The Sullivan machine drove 22 holes in the same time to a total depth of 1,384.6 ft. at a labor cost of \$687.04, explosives and freight \$32.48, which is equivalent to 51.9 ct. per ft., indicating that in hard driving the Sullivan is slightly superior.

Comparing these two same machines on a single hole each, we have:

	Carpenter.	Sullivan.
Loose material	0.0 to 42.6	0.0 to 53.3
Hard packed	42.6 to 72.0	52.3 to 74.5
Rock	72.0 to 73.8	74.5 to 75.8
Time boring (including 1 rainy day) ..	3.85 days	4.25 days
Cost per foot.....	43.7 cts.	45.8 cts.
Dynamite (40%) ..	3.5 lbs.	5 lbs.
Electric exploders...	7	5
Time removing drill rod	9 mins.	13 mins.
Time removing casing	39 mins.	30 mins.

Other comparisons might show advantage to the other machine.

As our business was to locate the rock, I caused the men to drill into and blast upon it, thus making sure of it. The rock drills come along later, but are not subjects of this article.

Neither of these machines is adapted to drilling in rock. They can drive the casing to the rock and no further.

Lead valued at \$7.451 was produced in 1907 in New Hampshire, Georgia and Virginia, the last state furnishing the bulk of the output.

Cost of Reconnaissance Survey for Railway Location in Alaska in Winter.

BY FRED. LAVIS,* M. AM. SOC. C. E., M. AM. RY. ENG. AND M. OF W. ASSOC..

The following costs of a reconnaissance survey for railroad location in Alaska in the winter of 1906-7 were furnished the writer by Mr. H. R. Gabriel, Locating Engineer, Katalla, Alaska. The payroll was as follows:

	Per month.
Chief of party.....	\$ 250
Transitman	125
Topographer	100
Draftsman	100
4 dog mushers	400
2 axemen	200
1 rodman	100
Cook	100

Total\$1,375

The total cost of the survey was \$13,500, distributed as follows:

Salaries	\$ 8,050
Subsistence	2,810
Cost of 22 dogs at \$60 each.....	1,320
Feed for dogs.....	1,320

Total\$13,500

Average cost \$50 per mile.

The survey covered a route 270 miles long between Fairbanks and Seward, Alaska, and was made between Jan. 1 and May 25, 1907. For a period of three weeks no work was done, the temperature ranging from 60° to 70° below zero, but work was carried on when the temperature was 36° below. The dogs were worked in four teams and on newly broken trails hauled 500 lbs. per team; they were fed on bacon, rice, and fish which cost 40 cts per day per dog.

The camping equipment was very light, consisting of one 10x12 ft. and two 14x16 ft. tents, two Yukon stoves and but very few dishes.

The average distance between camps was 10 miles, and but 4 or 5 days were spent in each camp.

The following is the list of rations allowed:

	Lbs.
Flour per man per day.....	1 to 1.25
Beans per man per day.....	0.25 to 0.50
Rice per man per day.....	0.12
Bacon per man per day.....	0.12 to 0.25
Ham per man per day.....	1.00
Dried fruit per man per day....	0.20 to 0.25
Dried corn per man per day.....	0.10
Sugar per man per day.....	0.30
Butter per man per day.....	0.16
Salt per man per month.....	0.75
Pepper per man per month.....	0.05
Other spices in proportion to pepper.	
Tea per man per month.....	0.50
Coffee per man per month.....	0.67
Cocoa per man per month.....	0.33
Dried potatoes per man per month	0.08

*Author of "Railroad Location Surveys and Estimates."

Rolled oats per man per day.....	0.08
Corn meal per man per day.....	0.08
Canned milk (can) per man per day	0.16
Macaroni per man per day.....	0.11
Cheese per man per day.....	0.08
Lard per man per day.....	0.05
Crystal eggs per man per month.	0.33
Baking powder 1.5 lbs. per 50 lbs. flour.	
Yeast cakes, 12 men per month, 10 pkgs.	
Soda, 12 men per month, 1 pkg. Sour dough bread was used.	
Concentrated vinegar, 12 men 6 months, one 6 oz. bottle.	
Mustard, 12 men 6 months, 4.5 lbs.	
Olive oil, 12 men 1 month, 0.1 gal.	
Beef tea, 12 men 1 month, 2.0 jars.	

This reconnaissance was a stadia survey, all distances both vertical and horizontal being measured with the transit, no level was used; topography sufficient to make a rough projected location and fairly accurate profile where it varied from the main line run, was taken with a clinometer.

It will be noted that all the information necessary to make a fairly accurate projected location was obtained on this survey at a comparatively small cost. Its value lies somewhere between the ordinary reconnaissance and the so-called preliminary location which should properly be a preliminary survey.

A preliminary survey of this line if properly made would have given more accurate detailed information, but its cost would have been between \$250 and \$350 per mile according to statements of actual costs of preliminary surveys in Alaska, made by Messrs. Cryderman and Kyle in a paper read before the Pacific Northwest Society of Engineers early this year.

The stadia furnishes accurate (within the really necessary practical limits) information as to distance, direction and elevation, which can be obtained in no other way as cheaply, and without any one of which it is impossible to form any reliable estimate of the practicability of any line or its cost, the addition of a very limited amount of topography taken by an experienced topographer enables a projected location to be made which should be well within a close approximation of the final line.

In regard to the salaries given they seem too low. The transitman, topographer and draftsman were not paid any more than good men get in the older parts of the United States where conditions of existence are not so rigorous; without intending any reflection on the men composing the party, the writer believes that in these positions competent men would be worth at least 50 per cent more than was paid on this survey.

The Board of Public Works of Los Angeles, Cal. has awarded the contract for constructing the South Antelope Division of the Los Angeles Aqueduct to P. A. Howard, Los Angeles, at \$529,000. Bids for the work were opened Nov. 30.

Methods of Making Tight Joints in Pipe Sewers.*

B. E. BRIGGS.†

The importance of tight joints in pipe sewers was impressed upon my mind early in life in a small western town for which I prepared plans and specifications for a sewer. It was my first experience in this sort of work and I prided myself that I had fixed the joints so that none of the sewage would get away, by providing that the pipe layer should use his hands in applying the cement mortar until the joints were evenly filled on the bottom, sides and top of the pipe, and that the joints be swabbed from the inside to remove any mortar that might have passed through between the ends of the pipe. The town council decided to import from a neighboring city an experienced sewer man. He proved to be a big husky son of Erin, who, after looking over my specifications proposed to tell me "more in a minute about sewers than the person who wrote those specifications would ever know." He said, "the joints should be open on the bottom so that a portion and sometimes all the water would seep out, thereby causing less odor at the outlet," and added, "whoever heard of a man using his hands to place mortar when trowels were made for that purpose," together with many caustic remarks which caused my ears to burn for days.

Some 2,000 feet of sewers were laid under those specifications by the experienced sewer man from the city, but not under my supervision. So well did the contractor carry out his idea of open joints that when, several months later, I examined the work, I found, to my great mortification, a small creek of spring-like water flowing from the outlet, the sewers having drained a number of wells and cisterns along their course.

The ordinary contractor is averse to making tight joints, arguing that they are an unnecessary expense. I have found it exceedingly difficult, and in many cases impossible, to satisfactorily impress on the average person that has to do with the laying of sewers, the importance of making the joints tight, and I have personal knowledge of cases where due consideration was not given this important feature in sewer work by those who prepare plans and specifications for sewer systems. I recently examined a few sewers with a view of determining as near as possible the exact amount of infiltration. To my surprise I found that in one extreme case fifty-two gallons per minute was flowing from 420 feet of 9-inch sewer laid in 1896 for a real estate company. There is but one small residence connected with that sewer.

Sewer contractors have frequently assured me that it is not at all difficult to make tight joints in a dry trench, meaning probably that the joint they make, though imperfect according to my standard, would

answer the purpose under such conditions. I have found, however, that when they were permitted to use water to settle the earth in the trench, a method which I avoid if possible, there was considerable leakage into the sewer whether the trench was dry or wet.

The Department of Engineering of the city of Erie, which I represent, has expended during the past fifteen years a great deal of money repairing breaks in sewers and streets, caused by defective joints. In an effort to stop that financial leak on future improvements, I procured copies of sewer specifications from neighboring cities and personally experimented with every scheme suggested for making tight joints. All kinds of trouble was experienced in trying to persuade or compel the pipe layer to follow instructions and give the various methods a fair trial. The main fault seemed to lie in his failure to properly place the gasket in the socket under the pipe. For after a pipe was finally set, it was often found that the gasket, on the under side, was either out of the socket or had been caught by the pipe which was being laid and jammed between the ends of the two pipes. From the point of view of the inspection, at the top of the trench, the joint would appear to have been perfectly made. It soon became evident to me that success depended as much upon the man in the trench as upon the method. The man had to be taught and this I did by giving demonstrations.

I decided to use a fairly large oakum gasket, prepared in advance in lengths sufficient to pass around the pipe and with the ends lapped over enough to equal the diameter of the pipe. The gasket should be immersed for several minutes before using in a bucket of Portland cement and water mixed in the proportions of about one to one. It should be so placed in the bucket that it can be readily removed and speedily placed in position by the pipe layer's assistant by taking one end in each hand, in which position, he draws it around the end of the pipe as it is being laid, or he drops the center of it in the lower part of the socket of the pipe previously laid and the next pipe is laid on it. Then the ends of the gasket are drawn across the top of the pipe and it is driven into the annular space, working from the sides to the top, after which the joint is neatly trimmed with stiff mortar. Either manner of placing the gasket, as mentioned above, is satisfactory in a dry trench, but in a wet trench the best results are obtained by placing it around the end of the pipe as it is laid.

The greatest difficulty encountered was to procure a desirable oakum and in such form as to insure economy and dispatch in preparing the gaskets. The common practice of using plain or tarred baled oakum, from which the contractor twisted his gaskets, proved unsatisfactory because the gaskets were of uneven thickness and could not be forced into the joint, and the

tarred spun oakum was discarded because it would not absorb the cement. An investigation among the dealers in hemp, from which oakum is produced, revealed a product spun into strands, of which two or more were twisted into a loose rope called "hemp packing." It can be cut into the desired lengths with a very small per cent of waste and it absorbs a large quantity of the thin cement mortar. One strand is about the proper thickness for an eight-inch pipe, and two strands for a twelve-inch pipe. By using the largest gasket that will permit the pipe to enter to the full depth of the socket and having it well filled with cement you will make a good tight joint, although the pipe layer may neglect, as he often will, to fill the lower part of the socket with mortar.

As the joint is the weak point in all pipe sewers and the cause of most of the trouble, I considered it advisable to eliminate as many joints as possible, which was accomplished by adopting the three-foot lengths of pipe with deep, wide sockets in place of the standard pipe in common use. A local pipe dealer informs me that the long pipe, of twelve-inch diameter, cost about 3 per cent more per foot than the standard pipe. We still permit the use of standard lengths of pipe, to some extent, when they are cemented together in pairs for about four days before laying. The difficulty of safely laying a piece four feet long was carefully considered, and in order to have it evenly bedded in such a position that it will not break, the contractor is required to make a soft bed in a hard bottom trench, remove the earth from beneath each collar, and in back filling have a man stand on the pipe to detect and prevent any moving of the pipe while he tamps the earth around it, alternating from side to side, with an iron tamper similar to that used in railroad track work.

An argument in favor of laying the longer sections of pipe, aside from the fact that there are a less number of joints to be made in the trench, is that owing to their increased weight they are less liable to crawl under the weight of a sliding back fill, which no doubt, is the cause of many open joints in wet, heavy soils.

As the greatest difficulty in producing a tight joint occurs in a very wet trench where the best possible joint is most necessary, I have devoted more time in an effort to accomplish the desired result under such conditions, and have finally adopted and required the use in very wet trenches, of the W. S. Gasket, which, I believe, is a patented article. These are made for various sizes of pipe and consist of a narrow bag of cheese cloth, slightly longer than the outer circumference of the pipe, with a strand of oakum passing through one side. Then the bag is divided into pockets by means of pasted seams, and filled with cement. The paste is readily dissolved by the water, permitting the cement in the pockets to unite as the gasket is driven into

*Abstract of paper read at Society of Municipal Improvement, Atlantic City.

†City Engineer, Erie, Pa.

the annular space. The use of this gasket runs the cost, per joint, up to about three times that of the common oakum and cement filled joint, but an amount equal to that difference is allowed the contractor on each joint. The city furnishes the gaskets to the contractors at cost.

Another method of making a good tight joint in the water is by the use of a mixture of one part coal tar and three parts of Portland cement thoroughly mixed into a putty. After an oakum gasket is placed this putty is forced in by hand. The operation is simple and effective against the water. The workmen, however, object very seriously to the tar on their hands. The material required for one joint for a 12-inch pipe with deep and wide socket depends largely on the size of the gasket, but ordinarily one pint of tar and three pints of cement completely fills the joint. The material best suited for this work is called hydrated tar, which is crude coal tar with the ammonia water removed.

In several instances, when repairing breaks in sewers carrying a large amount of water, where it was found impossible to stop leaks at the joints with oakum and cement, I have used plaster of paris with oakum with fair success, afterwards finishing the joint with cement mortar. The plaster is made in a thin paste and worked into the gasket until it contains all it will carry. As the plaster sets very quickly the work of preparing and placing the gasket and of setting the pipe must be performed with great rapidity.

The methods outlined above have thus far proved satisfactory. Of course time alone will prove whether they are the best or not. It is, however, an indisputable fact that the success of any method depends largely upon the intelligence of skill of the workman. Also, that the average man working in the trench today is a very different specimen from the one of twenty years ago. The foreigner of today cannot be depended upon to understand or follow verbal instructions. I find, however, that he learns quickly by sight, and will follow a given line. It is to this fact that I attribute the success of my methods.

The U. S. Civil Service Commission will hold an examination on Jan. 13-14, 1909, to secure eligibles from which to make certification to fill a vacancy in the position of junior physicist in the Technologic branch of the Geological Survey, at a salary ranging from \$1,080 to \$1,500 per annum.

The best daily record for steam shovels the Atlantic Division of the Isthmian Canal in October was made by shovel No. 102, working at the Gatun Locks, which excavated 1,888 cu. yds. of material. The material excavated was rock. The best monthly record was made by shovel No. 101 which excavated 4,280 cu. yds. of clay and 21,570 cu. yds. of rock in 26 working days.

Underground Insulation of Steam and Hot Water Pipes.*

BY HARRY GILLET.

Why do we insulate underground steam and hot water pipes? In order that we may carry our steam or hot water the required distance with the least possible loss of heat or power. The insulation of such pipes can only be obtained by confining that pipe within a covering, which contains dead, dry air split up into small parties by the use of some non-conducting, indestructible materials, felted or massed together. Underground insulation of such pipes is difficult for two reasons: First, on account of dampness getting into the covering (water being a good conductor of heat) which cannot be readily driven off, the pipes being confined by the earth; and secondly, that the coverings themselves are liable to be attacked by destroying influences found in the earth itself. These combined with the heat of the pipe inside and dampness on the outside of the covering, means certain death sooner or later to anything of an organic nature. Consequently, the future insulation of these pipes must of necessity be confined to methods and materials which will positively safeguard the pipes against such influences as above mentioned, and so far as present knowledge permits this seems to be either the tunnel or some form of conduit composed entirely of inorganic substances. We will consider these two types.

No one will dispute the statement that a tunnel is a pretty substantial proposition, but in a good many ways it has advantages which are worth consideration. The pipes are always accessible and if a leak occurs there is not much trouble in locating it so that repairs can be made without much difficulty. New pipes can be added from time to time as occasion requires, the tunnel being erected in a permanent manner and of size sufficient to accommodate additions. On the other hand the first cost is very high, the excavation being relatively much larger than would ordinarily be required for the number of pipes contained. The pipes must be separately insulated and as it is never thought necessary to cover the flanges under such conditions, the loss of heat from the pipes is sufficient at all times to comfortably heat a space, as a rule, approximating about the same number of cubic feet as are contained in one-quarter of the buildings which are to be heated. The argument is sometimes advanced that once this space is heated the loss is very slight, and to some extent this is true, but not by any means entirely so.

The other system is that using "Vitrified Sectional Conduit." All the materials are absolutely inorganic, the shell being composed of a carefully selected and thoroughly ground and mixed combination of stone ware clay. After the material passes from the molds it is properly treated before he-

ing placed in the kiln to avoid warping of the sections, this being extremely important. The conduit is scored in process of manufacture so that it can be readily split, which is done before shipping, each half being so marked that it can be identified on arrival in order that the original tops and bottoms may come together. Before splitting, each conduit length must sustain a transverse test between hardwood supports which cover one-third of the entire circumference of the conduit.

The fitting or insulating material is composed of asbestos fiber and sponge, which is so intermixed that a maximum number of confined air-cells are obtained.

The pipes are carried on roll frames embedded in concrete, special tees being provided for this purpose, and whenever it is found necessary to anchor or turn a corner, brick pits are built. Almost any number of pipes may be placed in a single conduit and it is purposed that no pipe shall have less than three inches of the insulating material around it. The pipes are perfectly insulated and the entire conduit, with its contents, is self-contained. The loss in pressure is practically only that caused by the friction between the steam or hot water and the interior surface of the pipes.

This conduit can be laid within six inches of the top of the ground, snow not melting directly over it, as long as the atmosphere is below freezing point, according to actual observation.

The question of installation is a vital one with this, as with all other mechanical devices, especially so as it is of the greatest importance that no leakage of water shall occur. The lower half sections and the roll frames must be in perfect alignment, and it is absolutely necessary that the pipes shall be tested with a cold water test of at least 50 per cent in excess of the steam pressure to be carried before the top half-sections are placed or any insulating material put on; neither should caulking or rusting of joints be allowed. The job of steam fitting must be perfect and experience teaches that by following this course it will remain perfect.

Observation tees are provided in case it is necessary at any time to look for a leak, but after a long term of years, during which time many thousands of feet of the conduit have been placed under ground throughout the eastern states, it was proven that no observation is necessary and the reason is simple. In the first place the necessity for careful and proper installation has been duly recognized and taken care of; there is no chance of anything attacking the pipe from the outside, and with this danger eliminated the chances for necessity of renewal are very slight. In case, however, it does become necessary, after a long term of years, the defective pipe is easily located and the trouble and expense of renewal quite small. On the other hand the results to be obtained are almost marvelous. We have one case in mind, at

*A paper delivered before the Ohio Society of Mechanical, Electrical and Steam Engineers at Toledo, Nov. 21, 1908.

Andover, Mass., where a line 600 feet long was tested and the gauge at both ends showed exactly the same pressure, and other cases could be mentioned where approximately the same results have been obtained; in fact no case was ever reported where, with proper installation, the efficiency test showed less than 90 per cent.

Formerly wooden covering was used but this would crack and allow the surface water to enter the crevices, so that the heat losses were sometimes equal to 30-40 per cent of those of bare pipes. A new and good job would show an average loss of 20 per cent of the loss of an uncovered pipe, or, in other words, a saving of 80 per cent of heat otherwise dissipated. Various substances have been tried out but most of them deteriorate so easily, so that financially nothing was found to equal, as an efficient insulating material, water and heat proof substances which could be molded into convenient shapes, and be made to entrap a lot of air; for, still and

Estimating the Cost of Manholes from a Diagram.

BY JOHN WILSON.*

Herewith is given a diagram for estimating the quantities of materials in manholes; and, at given prices of materials and labor, the cost of the manhole can likewise be ascertained. The diagram shown is for a 4-ft. manhole.

Having the depth of the manhole given, the number of brick, the amount of sand, cement, mortar, the cost of labor, and total cost of manhole complete, plus 15 per cent profit, may be taken from the diagram.

Thus for a 15-ft. manhole, follow vertical line to intersection with brick curve, thence horizontally to left read 2,600. From the intersections of the last horizontal line with the sand, mortar and cement curves, respectively, read vertically above 1.88 cu. yds. of sand, 2.22 cu. yds. of mortar and 4.6 barrels of cement. To ascertain the cost, follow vertical line from

LETTERS TO THE EDITORS.

The Competitive System of Contracting vs. the Fixed Fee System.

Sir: I beg to be allowed to comment as follows upon your editorial in the issue of Nov. 18 of "Engineering-Contracting," entitled "The Competitive System of Contracting vs. Fixed Fee System."

There are two points in this editorial which are worthy of comment, the first being that the principle of selfishness and ambition, which originally drove Satan from Paradise, is the great uplifting force that makes for progress and civilization; proving that from the worst faults inherent in human nature, the greatest benefit to the human race may be gained.

It is this very principle which is at the foundation of the fixed commission system of contracting. The method was originally inaugurated and is being perfected through the idea of greatest gain to self. Previous to its conception many contractors had realized that the competitive system neither made money for themselves nor produced good work in which they could take pride; for, combined with the idea of money making, is or should be, the joy that every workman must feel in his work.

The second point, which is conspicuous by its absence in your editorial, is the fact that men *do* take pride in their work. The only real and lasting joy in life is the joy of creation. This principle is the foundation of the inventive genius of this nation. It is this which induces a workman to make some little addition to his machine which does not at all increase his wages but increases the machine's efficiency. It is this which induces the draftsman in his office to design and perfect some new principle of construction for use in the field, which does not increase his weekly pay one cent, but gives him a feeling of having contributed to the progress of the firm. It is this feeling in every construction force—the idea of "doing a good job"—which spurs every mechanic and laborer that is worth his salt, and which is fully as strong as the inducement that every man feels to make money.

No constructor in this present day of fierce competition has a keener incentive to do good work at a low price than the man who is operating on the fixed commission basis. In the first place, he must establish his reputation, otherwise he cannot get work. In the second place, that reputation must be one that sustains him in his statement that he does work at a lower cost than can be reached by the competitive system.

A pertinent instance of this fact occurred during our experience of the present year. A certain small piece of construction work was submitted to competitive bidding upon certain prepared designs, and the lowest bid secured was \$34,500. Our special designs were afterwards approved as an alternate and our estimate of the cost of the work

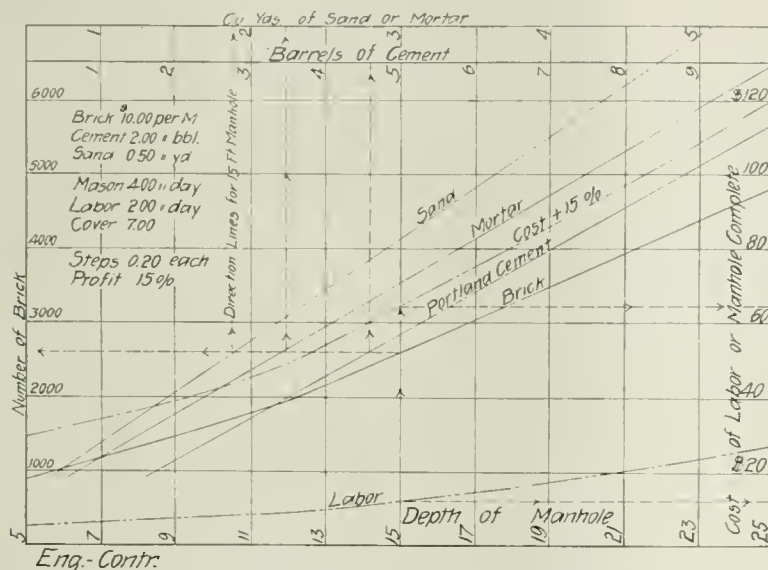


Diagram for Estimating Cost of Manholes.

stagnant air is the very best kind of an insulator.

After many laboratory tests have been made on a large variety of substances, asbestos was found to fill the requirement best. It can be worked up easily into any shape, dense or loose in construction, and is not easily damaged by vibration of pipes, etc.

An idea as to the amount of energy lost due to condensation of steam in pipes may be derived from the statement that six ft. of 6 in. pipe uncovered, will cause a loss of energy each hour, equivalent to that generated by one pound of coal under average conditions. A good covering reduces this loss at least 80 per cent.

The total number of immigrant aliens who entered this country in the last fiscal year was 782,870, being 502,479 less than in the fiscal year of 1907. In addition to 782,870 immigrant aliens admitted to this country, there were admitted 141,825 classed as "nonimmigrants," making a total of 924,695.

bottom to intersection with the cost curves, and read horizontally to right, cost plus 15 per cent, \$64, of which the cost of labor alone is \$12.50.

The curves allow for a double layer of brick in the bottom and the outside of the manhole to be well plastered. It is an easy matter to draw similar curves to meet local conditions and thus secure a very ready method of making estimates.

It is expected that the Isthmian Canal medal will be awarded in December. These medals are to be distributed to all employees of the Commission who have served two or more years on the canal. The medal will be of bronze about 1½ in. in diameter and will bear on one side a portrait of President Roosevelt and on the other a view of the Culebra Cut, in the finished canal, with steamers passing through.

*City Engineer of Mankato, Minn.

was \$12,500, but there was no guarantee whatever. This sum included our own fixed commission.

If no stronger motive were recognized than the sole motive of money making there would have been no reason why we should have exerted ourselves to produce the required result at a less cost than was named; no reason why improved methods should be used, nor modern machinery be employed. The fact as demonstrated, however, was that the very best of tools, most modern ideas and most scientific methods were employed, with the result that the work actually cost \$28,365, a saving to the owner of something over \$1,000. This was an exceptional case where everything worked to good advantage. Here were the competitive methods and the fixed commission method in direct competition on the same piece of work. Today, after the work has been satisfactorily completed, which method do you suppose that owner would select were he called upon to undertake a similar enterprise?

You admit in your editorial that this system, which induces harmony and co-operation between the owner, his architect (or engineer) and his constructor, is a good system and the best system that we know of today, when applied to hydraulic development, architectural work and most underground construction where conditions cannot be ascertained in advance. This would include possibly three-quarters of the public work which is now being done in this country; not three-quarters of the actual amount of money expended, because the greatest amount expended is on "railroad work," which you have placed in a class by itself. I presume that you refer to the ordinary open rock and earth work to which you also add grading and street surfacing. This is work in which no particular engineering knowledge is required by the contractor, and work on which it is not necessary that his general experience in construction should be very broad, the necessary and indispensable requisite being the constructor's executive ability and his experience in handling men.

I am aware that very much of this class of work has been executed under the fixed commission method, although more or less has been done by the percentage method in the improving of estates, landscape gardening, etc. In fact, I am *thoroughly* convinced that the fixed commission method is the best; but from lack of information can not express myself clearly so far as open earth and rock work is concerned.

That you perfectly agree with me that hydraulic construction "lends itself admirably to the fixed fee system of contracting" shows the open and unbiased attitude which "Engineering-Contracting" has maintained and I believe will continue to maintain.

Thanking you for your courtesy in this open expression of opinion through the columns of your publication, and in the hope that it may serve to arouse thought and

perhaps some discussion, I have the honor to remain
Yours very truly,

C. H. EGLEE,

General Manager, Ambursen Hydraulic Construction Company, Engineer-Constructors.

176 Federal St., Boston, Mass.

Nov. 23, 1908.

Engineers as Reserved Army Officers.

Sirs.—I have often noticed the immense sums of money that the U. S. is spending on its military establishment and wondered if we had a great war if it would be possible to obtain sufficient trained officers.

I am well aware that our regular establishment, while very small and short of officers, is efficient and most of the officers are capable of handling much larger commands than they have at present. The militia has also been greatly improved in the past few years, but usually the line officers are elected by the men and the field officers by the line officers. This usually means that the most popular man gets the commission. Few of these officers hold places in civil life that tends to fit them to command troops.

The War Department also conducts examinations to secure lists of persons especially qualified to hold commissions in any volunteer force which may hereafter be called for and organized under the authority of Congress. There is a lot of "red tape" connected with these examinations and I understand that very few are availing themselves of the chance.

I desire to call attention to the fact that there exists in the states today a large body of men whose training and occupation in civil life, would fit them with very little military instruction to be among the very best officers we could have. I refer to contracting or construction engineers. Ordinarily a young engineer starts his practice on survey work, then designing and construction, and some finally work into contracting, as it seems to offer better chances for advancement. It does not seem to take them long to get a large and varied experience covering most of the branches of engineering and construction. Many of these engineer's experiences cover from the tropics to the circle (Arctic) and many have worked in hostile countries where they would get considerable military experience.

The points which either a successful army officer or contracting engineer should have are so similar that very little military instruction would make first class officers out of contracting engineers.

Should the Government adopt my suggestion, I would suggest that they give their applicants for volunteer officers letters of introduction so they could go to any regular militia post and drill or use such equipment as they could to perfect and keep themselves in practice, in tactics, etc., and lay out a course of "home study."

If they complete these preliminaries in satisfactory shape and show that they are adapted to the services, allow them to enter the staff schools as special students and attend the maneuvers as observers. It should be borne in mind that engineers are nomadic and there are times when it is impossible to obtain employment. By adopting a course to their needs it would cost the department very little and the engineers little, save spare time. I believe the results would be gratifying to all concerned.

Speaking of the medical examination, if the applicant is free from organic diseases, he should pass. There is no doubt many who could not pass the strict army medical examination due to some slight defect like slightly hard hearing, which may have been caused by going into some working to try to help some poor fellow who has been a victim of a premature blast.

I do not think that it would be advisable to place the men in the engineering department of the army, but keep them in a special reserve, that could be called upon in time of need. Then they could be scattered through the army a few to each battalion and in such commands as their previous training and experience would justify. When a volunteer force takes the field, there are always a lot of changes and some are compelled to drop out. Those vacancies could be filled from the special reserve.
ENGINEER.

Method for Rapid Computation of Earth Work.

SIRS: In ENGINEERING-CONTRACTING of Nov. 11, I note a method of estimating earth yardage from a railway profile by the use of a specially prepared scale. Allow me to call attention to the fact that a similar scale is shown in Lavis' "Railway Location Surveys and Estimates," p. 93, which is better than the one in your Nov. 11 issue.

Yours truly,

Railway Engineer.

The New York, New Haven & Hartford R. R., according to press dispatches, has arranged for beginning work shortly on improvements involving the expenditure of \$30,000,000. These improvements are said to include the electrifying of a 6-track line from New Rochelle to 129th St., New York City, the construction of a tunnel under the East River to Astoria, thence to Long Island City, with another East River tunnel and subway to a huge passenger station to be erected on the block bounded by Fourth and Lexington Ave., 32nd and 33rd Sts., New York. A connection with the Pennsylvania will be made in Long Island City, according to the report, and a New York, New Haven & Hartford terminal station will be built on the old Park Ave. car barn site. Part of the contracts are stated to have been awarded to the recently formed firm of Bradley, Gaffney & Steers, of New York.

Discussions Before the Technical League on the Blackwell's Island Bridge.

Some significant facts regarding the Blackwells Island Bridge deficiencies are brought out in a recent discussion of this structure by the members of the Technical League of New York City. Through the courtesy of the Secretary of the League we have been furnished with three of their discussions of most general interest; two of them we print here and the third will be printed in our issue of next week. As the membership of the League is secret, the names of those writing these discussions are not given, but we have distinguished the separate authorship of the two discussions printed here by means of numerals:

(1) Since a recent report on the condition of the Blackwell's Island Bridge has put the engineers and contractors who worked on this bridge in an extremely bad light and has reflected on the whole engineering profession, it might be well to lay before you the few facts I have been able to gather. Why these were not mentioned in the report I can not say.

The first thing, almost, that I was able to find was that the whole question of safety, or of bad design, hinged on the assumed loadings, however, not on the amount, but upon their distribution. The report was based on the stresses in the members from the congested live loads placed upon isolated parts of the structure. The structure was designed and built to carry a continuous congested live load from end to end or upon any portion of the bridge whatever. The condition of loading for members of the island span will serve as an illustration. The first condition called for a load on the river spans of approximately 1,200 ft. and 1,000 ft. long with absolutely no load on the island span 600 ft. long. Such conditions might arise on a four-track railroad bridge with 200 or 300-ft. divisions, but here is a case of twelve varied lines of travel and 1,000-ft. divisions. The second condition called for a load on the river spans and the island span approximately 2,800 ft. long. The difference in applying the loads upon the island span brought about the most divergent results and evidently determined the recommendation in the report for reduction in dead and live loads. In referring to these conditions of loading hereafter the one used in the investigation upon which the report was based will be called the "theoretical," the one used in designing the structure the "actual" loading. The last term may be misleading in that it might imply a condition that could occur several times in the life of the bridge. The speaker believes this condition will never occur. The term is used only to distinguish it from the absolutely impossible loading adopted in the calculations leading up to the report. Imagine this latter condition if you can. Two footwalks loaded like a B. R. T. car from side to side with people blocked at each end of two 1,000-ft. divisions; two

lines of wagon traffic going east, two lines going west, two lines of trolley cars and two lines of elevated trains, eastbound, two lines of trolley cars and two lines of elevated trains westbound, each line with traffic packed tight and blocked in two widely separated places in their several directions of travel. Or to put it in another way, twenty-eight separate and distinct though simultaneous blockades, each one congesting traffic for a length of nearly two "long" city blocks. The distinguished investigators may be able to figure this out by the laws of chance but they could not get it on the bridge even with artificial barricades. The "actual" loading used in designing and building the bridge assumes twelve simultaneous blockades congesting traffic in the same manner and even this I criticize as too severe. No attempt was made in the report to show that other conditions of loading might have been assumed. In fact no effort was made to correct the impression that gross and inexcusable errors had been made by the engineers and the contractors.

I have been informed of another point that seems to have been overlooked in the report. For the present only, the roadway is to be paved for all the clear space between trusses or about 53 ft. in width. The extra width of roadway is to remain only while car travel is light and can be handled on the tracks outside the trusses. A broad, noble highway, eminently fitted for the great automobile traffic that will pass over this bridge is thus afforded. When car travel becomes so heavy that the inner tracks must be used the millionaire must perforce surrender part of his speedway to the proletariat. Then, and only then I am assured, will this roadway be changed, part of the paving removed and the roadway reduced to 33 ft. But this process would mean a reduction in weight of about 2,200 lbs. per lin. ft. The report did not take this into account at all, though this is a very vital condition. While on this question and without any intention of criticizing the engineers of this bridge, I would suggest that, in the elevated railroad track work and footwalks which will undoubtedly be installed within three or four years, considerable reduction in the weights, assumed and given to the investigators, can be affected. I believe these figures are too high by about 1,200 lbs. per lin. ft.

However, proceeding with the first two conditions, namely, the difference in the "theoretical" and "actual" conditions of loading and the exclusion of the 2,200 lbs. per lin. ft. dead load which will have been removed long before there is a call for eight tracks on the bridge. I have verified the two sets of stresses on the island span. From these figures I found that if the "theoretical" loading with its impossible conditions of live loading and the extra 2,200 lbs. of dead load are taken, the unit stresses developed are alarming and would naturally form the basis of an unfavorable report. An examination of the unit stresses developed by the "actual" load shows that in a few

cases these over-run the allowed stresses by an extremely small amount, from $1\frac{1}{2}$ to 3 per cent. With the further reduction in the dead load to be added in the future which I have suggested, all the stresses would be well within the allowed unit stresses.

Altogether the result shows that the contractor's computations were remarkably close, that the unit stresses are well within the limits allowed, and that the bridge can safely carry the full specified live load without any train spacing or any reduction whatsoever.

The speaker has computed members in the other divisions of the bridge in the same manner and finds about the same results, alarming if the "theoretical" loading is taken, safe if the "actual" loading is taken. In the majority of cases "alarming" reduced to "safe." The island span showed the greatest divergence. It might be said that the report was right, if, whatever one may stretch one's imagination to conceive may be taken as legitimate loading for a structure. In other words, the elastic limit of the imagination and of the structure must be arrived at simultaneously. May heaven pity the profession if a twenty or thirty story office building is reported on in the same manner, assuming a congested live load at its full value for every story from roof to basement.

The speaker would like to say, in closing, that he has made these remarks in no spirit of actual criticism of the report, nor as an attempt at justifying any errors, but to demonstrate that no colossal blunder has been made, that the work has not been handled by a crowd of men ignorant of what engineering means, and mainly because the conclusions that may be made from this report, if unanswered, reflect not only on the engineers and contractors engaged on this work who should have made it their first duty to answer it fully and completely, but it reflects upon you and me and every member of our profession.

(2) When the construction of the Manhattan bridge was contemplated a Board of Engineers was appointed by the mayor to investigate the system of loading and the unit stresses to be used.

This board appointed by the mayor consisted of the following eminent engineers: Geo. S. Morison, Mansfield Merriman, C. C. S. Schneider, H. W. Hodge and Theodore Cooper.

The same loading and unit stresses as were approved by this commission were incorporated in the specifications for the Blackwell's Island Bridge. This specification was given by Mr. Lindenthal to the assistant engineers of the Bridge Department to design the Blackwell's Island Bridge, and as this was an official order it had to be carried out. In other words, the designers in the department had to respect the official specification as authoritative whether they considered it correct or not.

This specifications called for a "congested loading placed so as to give the greatest strain in each part of the structure." It

called for a loading of 12,600 lbs. per lin. ft. and afterwards revised to 16,000 lbs. per lin. ft. with the following unit stresses: Nickel steel eye-bars, 39,000 lbs. per sq. in. Structural steel eye bars, 24,000 lbs. per sq. in. Riveted tension members, 21,000 lbs. per sq. in. Riveted comp. members, 24,000 lbs. 100 1/r

The elastic limit specified for nickel steel eye bars was 18,000 lbs., carbon steel bars 28,000, and plates and shapes 30,000 lbs. per sq. in. This gives the high percentage of unit stress to the elastic limit of 81 per cent for nickel steel bars, 86 per cent for carbon steel bars, and 80 per cent for plates and shapes. There seemed to be but one reason for such high unit stresses and that is the kind of loading used; namely, the "congested load."

This assumption of loading meant for this particular structure that the lower floor would have a continuous line of loaded trolleys on the four tracks, and the roadway a live load of 100 lbs. per sq. ft. The assumption for the upper floor loading meant that the two elevated tracks, or as afterwards revised that the four elevated tracks would be *stalled* with cars or trains, and the footwalks congested with a live load equal to 100 lbs. per sq. ft.

Now, in any engineer's mind this condition of loading is not only ridiculous but impossible. First, the footwalks could not be possibly crowded to give such a live load capacity. Second, a stalled condition of cars would only occur in case of an accident or a block on one or two tracks, which of course would not mean a *continuous* loaded portion of all the tracks. Besides traffic regulations prevent such a congestion and the loaded traffic to or from Manhattan is only one way during the rush hours of a day.

The loading of the roadway meant that it would be crowded with vehicles for a long distance on the bridge or a concentrated load of 24 tons on 2 axles, 10 ft. apart and 5-ft. gage assumed to occupy an area of 12 ft. by 30 ft. Such heavy loaded trucks are very scarce and even the ordinary vehicular traffic congested on one of our city blocks would not give 100 lbs. per sq. ft. loading.

Since these impossible conditions of loading were employed, the unit stress must have been made high to bring the material and the members of the bridge under a factor of safety. In other words, the high unit stresses endeavored to make the design economical under the impossible conditions of loading imposed.

The reasons for the variations and low stresses in the floor system as shown in the report must have been that provisions were made to run any kind of car or train on any of the trolley stringers with but little revision and at first cost for construction. This provided for future conditions that might arise in traffic and could be taken care of without the difficulties that were experienced in revising the Brooklyn bridge to accommodate the present traffic. Of course, this additional material added to the

dead load thus reducing the live load capacity of the bridge but the percentage of increase would be very small on a greater factor of safety on the trusses if the unit stresses as specified had not been so high. In other words, bridges with the common practice of loading and with unit stresses of 50 per cent of the elastic limit would give a factor of safety of four on the ultimate strength of the material used instead of reducing the safety factor to almost the minimum of one.

Since the Blackwells Island bridge shows overstress from the original loading and the high unit stresses in proportioning the members, the live load must be greatly reduced in order to bring this bridge within a proper margin of safety. It, therefore, is evident that the monumental blunder in bridge engineering is not the assistant engineers' fault in the department today but of a previous administration which officially ordered these high unit stresses.

The type of design containing the rockers may be subject to criticism as to economy in weight but primarily the responsibility and safety of any structure is determined by the unit stresses used. Why the engineer or engineers who were responsible for the specification of the Blackwells Island Bridge departed from the ordinary unit stresses used in bridges of many years of usefulness is hard to understand.

The Cost of a Highway Viaduct.

A steel viaduct for a highway was built in 1899, across Pincy Branch, Washington, D. C. It is 300 ft. long and consists of three towers (8 bents) and 7 deck trusses (3 tower trusses and 4 intermediate).

All trusses are 10 ft. deep; the 3 tower trusses are each 30 ft. long; two of the intermediate trusses are each 60 ft. long, and the other two (at the ends of the viaduct) are each 45 ft. long. The viaduct is 60 ft. high in the center and has a profile area of 12,000 sq. ft. below the floor level, which divided by the 300 ft. length gives an average height of 40 ft. The floor system is 15-in. I-beams (42 lb.) supporting 5x14-in. stringers (16 ft. long and spaced 2 ft. c. to c.), on which is laid the floor of 3-in. yellow pine. The trusses are 16 ft. apart, and the I-beams overhang them, giving a floor 24 ft. wide.

The assumed live load was 100 lbs. per sq. ft., or 12 tons on two axles 7½ ft. c. to c. The concrete pedestal piers rest on rock, and are 2 ft. square under the coping and rest on a stepped base 4¼ ft. square. The materials used were as follows:

Steel in bents or towers.....43,500 lbs.
Steel in trusses and floor.....77,700 lbs.

Total 121,200 lbs.

Timber 46,000ft. B. M.

The cost was:

Foundations, incl. abutments\$2,112

Bents or towers 2,820

Superstructure 5,635

Total\$10,567

This is equivalent to \$35.22 per lin. ft.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *ENGINEERING-CONTRACTING*. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 1001. **Roof and Floor Slabs.**—Northwestern Expanded Metal Co., 920-950 Old Colony Bldg., Chicago, Ill.

This is the third of the excellent series of pamphlets being issued by the above named firm, and it gives a variety of useful information regarding roof and floor slab design in reinforced concrete. The tables for designing slabs are particularly practical. Reinforced concrete designers should secure this series of pamphlets for filing.

No. 1005. **Cement Tools.**—Burrell Mfg. Co., Bradley, Ill.

This pamphlet illustrates and describes the X-1. All concrete block and brick machines, special molds, concrete cart and concrete mixer. The hand power and traction mixers shown will interest block makers and contractors for concrete curbing, sidewalk and pavement foundation. Complete instructions are printed for operating each of the several machines and there are several additional pages of useful data for cement workers.

No. 1006. **Buckets.**—J. S. Barron, 127 Franklin St., New York.

These buckets are made for contractors and for handling all kinds of heavy materials. They are made of wood with heavy iron bands and hoops on them. It is claimed that the bottom cannot be knocked out of these buckets even by horses stamping on them.

No. 1007. **Metal Hose.**—The American Metal Hose Co., 173 La Fayette St., New York.

A bulletin telling of the all metal hose and tubing being sold by this company for various purposes. These hose of different sizes are used for high pressure of steam, air, gas, ammonia and acid, and it is stated that it will outlast any other kind of hose.

No. 1008. **Water Rock Drills.**—The J. Geo. Leyner Engineering Works Co., Littleton, Colo.

A 48-page catalog devoted to the Water-Leyner drill, model six. This drill, designed for all kinds of rock work, carries water to the bit by hollow drill steel, and has done very efficient work in many of the mines of the west. The catalog describes the method of operating the drill, and shows photographs of drills at work.

No. 1009. **Dump Wagons.**—Kramer Wagon Co., Oil City, Pa.

A 52-page catalog describing the Kramer wagons, giving tables of dimensions, etc. This company manufactures dump wagons, solid bottom wagons, lumber wagons and heavy wagons for machinery. A very complete wagon catalog.

No. 1010. **Punching Machines.**—Henry Pels & Co., 90 West St., New York.

A 21-page catalog describing and illustrating hand power punching and shearing machines. These machines are well known to the building trade and have proven their great efficiency by their uniform excellent work. Contractors and engineers doing steel work will find these machines are money savers.

No. 1011. **Dump Cars and Industrial Railroads.**—Ernest Wiener Co., 50 Church St., New York.

A catalog of over a hundred pages devoted to the products of this well known company, who are railroad specialists for all industries. They manufacture all steel cars, and industrial railroads of varying gages, the steel ties being galvanized. This catalog should be in the hands of every engineer and contractor.

No. 1012. **Stamp Milling Machinery.**—Taylor Engineering Co., New York, N. Y.

This pamphlet gives line drawings of a number of stamp mill layouts and shows a variety of stamp mills, ore crushers, amalgamating pans, settlers, clean-up pans, barrels, ropes, and retorting furnaces. Conveying machinery for ore mills is also illustrated. Descriptive text accompanies the several illustrations.

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Dec. 9. Hollywood, Cal.	Dec. 2
Dec. 10. Memphis, Tenn.	Dec. 9
Dec. 11. Atkinson, Ill.	Dec. 9
Dec. 11. Greenville, S. C.	Dec. 9
Dec. 11. Fresno, Cal.	Dec. 9
Dec. 12. Richmond, Va.	Dec. 9
Dec. 14. Green Bay, Wis.	Nov. 25
Dec. 14. San Diego, Cal.	Dec. 9
Dec. 15. Washington, Ind.	Dec. 2
Dec. 15. Bridgeport, Conn.	Dec. 9
Dec. 16. Columbus, O.	Nov. 18
Dec. 16. Columbus, O.	Nov. 25
Dec. 18. Cincinnati, O.	Dec. 2
Dec. 19. Batesville, Ark.	Dec. 9
Dec. 21. Doylestown, Pa.	Dec. 9
Dec. 24. Sumner, Wash.	Dec. 2
Jan. 8. Salt Lake City, Utah.	Dec. 9

Buildings.

Dec. 9. Columbus, O.	Nov. 25
Dec. 10. Wausau, Wis.	Nov. 18
Feb. 10. Fort Terry, N. Y.	Dec. 2
Dec. 11. Fort Crook, Neb.	Dec. 9
Dec. 12. Sacramento, Cal.	Dec. 2
Dec. 12. Madera, Cal.	Dec. 2
Dec. 12. National Military Home, Kan.	Dec. 9
Dec. 14. Fort Meade, S. Dak.	Nov. 18
Dec. 14. Fort Greble, R. I.	Dec. 2
Dec. 14. New York, N. Y.	Dec. 9
Dec. 14. Kansas City, Mo.	Dec. 9
Dec. 15. Cincinnati, O.	Dec. 2
Dec. 15. Houston, Tex.	Dec. 9
Dec. 15. Parnassus, Pa.	Dec. 9
Dec. 16. San Jose, Cal.	Nov. 25
Dec. 16. Oakland, Cal.	Dec. 2
Dec. 16. Pensacola, Fla.	Dec. 2
Dec. 16. Providence, R. I.	Dec. 9
Dec. 16. White Plains, N. Y.	Dec. 9
Dec. 17. Circleville, O.	Dec. 2
Dec. 17. Harrisonburg, Va.	Dec. 9
Dec. 17. Cleveland, O.	Dec. 9
Dec. 18. Madison, Wis.	Nov. 18
Dec. 19. Passaic, N. J.	Dec. 2
Dec. 19. Carthage, O.	Dec. 9
Dec. 21. Seattle, Wash.	Nov. 18
Dec. 21. Cheyenne, Wyo.	Dec. 2
Dec. 21. Hot Springs, S. Dak.	Dec. 2
Dec. 21. Covina, Cal.	Dec. 2
Dec. 21. Belle Plaine, Kan.	Dec. 9
Dec. 22. Coldwater, Mich.	Nov. 18
Dec. 22. Mount Weather, Va.	Dec. 9
Dec. 22. Ramona, Okla.	Dec. 9
Dec. 23. Jersey City, N. J.	Dec. 2
Dec. 23. Porterville, Cal.	Dec. 2
Dec. 26. Americus, Ga.	Nov. 18
Dec. 26. San Jose, Cal.	Dec. 2
Dec. 28. Lake Charles, La.	Nov. 18
Dec. 28. Covina, Cal.	Dec. 2
Dec. 29. Alton, Ill.	Dec. 2
Dec. 30. Moultrieville, S. C.	Dec. 2
Dec. 31. Fort Howard, Md.	Dec. 2
Jan. 4. Saint Ste. Marie, Mich.	Dec. 2
Jan. 4. Lisbon, O.	Dec. 2
Jan. 5. Niles, Mich.	Dec. 2
Jan. 5. Frankfort, Ky.	Dec. 2
Jan. 6. Paris, Ill.	Dec. 2
Jan. 6. Fort Slocum, N. Y.	Dec. 2
Jan. 7. Johnson City, Tenn.	Dec. 2
Jan. 9. Murfreesboro, Tenn.	Dec. 2

Roads and Str

Dec. 9. Salem, N. J.	Dec. 2
Dec. 9. Muncie, Ind.	Dec. 2
Dec. 9. Corydon, Ind.	Dec. 2
Dec. 9. Huntington, Ind.	Dec. 2
Dec. 9. Pittsburg, Pa.	Dec. 2
Dec. 9. Mamaroneck, N.	Dec. 2

Dec. 9. Brooklyn, N. Y.	Dec. 2
Dec. 10. Frankfort, Ind.	Dec. 2
Dec. 10. New York, N. Y.	Dec. 9
Dec. 10. Pittsburg, Pa.	Dec. 9
Dec. 11. Mt. Vernon, Ind.	Nov. 25
Dec. 11. Cincinnati, O.	Dec. 2
Dec. 12. Purcell, Okla.	Nov. 25
Dec. 14. Fort Riley, Kan.	Nov. 25
Dec. 14. Kansas City, Mo.	Dec. 9
Dec. 14. Wabash, Ind.	Dec. 9
Dec. 15. Anderson, Ind.	Dec. 2
Dec. 15. Houston, Tex.	Dec. 9
Dec. 15. New York, N. Y.	Dec. 9
Dec. 15. Salisbury, Md.	Dec. 9
Dec. 15. Noblesville, Ind.	Dec. 9
Dec. 16. Brooklyn, N. Y.	Dec. 9
Dec. 17. Newton, N. J.	Nov. 25
Dec. 17. Fort Myer, Va.	Dec. 9
Dec. 17. Cleveland, O.	Dec. 9
Dec. 21. St. Paul, Minn.	Nov. 25
Dec. 22. Opelousas, La.	Dec. 9
Dec. 23. Cleveland, O.	Nov. 25
Dec. 23. Roanoke, Va.	Dec. 9
Dec. 23. Pittsburg, Pa.	Dec. 9
Dec. 28. Anderson, Ind.	Dec. 2

Sewers.

Dec. 10. El Centro, Cal.	Dec. 2
Dec. 10. Pittsburg, Pa.	Dec. 9
Dec. 10. Danville, Pa.	Dec. 9
Dec. 11. Louisville, Ky.	Dec. 2
Dec. 11. Montreal, Que.	Dec. 9
Dec. 11. Indianapolis, Ind.	Dec. 9
Dec. 14. Redfield, S. Dak.	Dec. 9
Dec. 15. Toronto, Ont.	Nov. 25
Dec. 15. Independence, Kan.	Dec. 2
Dec. 15. Beaumont, Tex.	Dec. 9
Dec. 15. Fitzgerald, Ga.	Dec. 9
Dec. 16. Baltimore, Md.	Dec. 2
Dec. 16. Brooklyn, N. Y.	Dec. 9
Dec. 18. Louisville, Ky.	Dec. 2
Dec. 21. Green Bay, Wis.	Dec. 2
Dec. 21. Muskogee, Okla.	Dec. 9
Dec. 22. Mt. Vernon, O.	Dec. 2
Dec. 28. Pipestone, Minn.	Dec. 2

Water Supply.

Dec. 9. New York, N. Y.	Dec. 2
Dec. 9. Grafton, Ill.	Dec. 9
Dec. 10. New York, N. Y.	Dec. 9
Dec. 14. Gridley, Cal.	Nov. 18
Dec. 14. East Grand Forks, Minn.	Dec. 2
Dec. 14. Winterset, Ia.	Dec. 9
Dec. 15. Eveleth, Minn.	Dec. 2
Dec. 15. Herriin, Ill.	Dec. 2
Dec. 17. Brooklyn, N. Y.	Dec. 9
Dec. 21. Astoria, Ore.	Nov. 25
Dec. 21. Astoria, Ore.	Dec. 9
Jan. 12. Connersville, Ind.	Dec. 2

Miscellaneous.

Dec. 9. Flathead, Mont., Saw and Grist Mill, Nov. 18	
Dec. 10. Ottawa, Ont., Steamer, Nov. 18	
Dec. 10. Memphis, Tenn., Street Lighting, Nov. 25	
Dec. 11. Cincinnati, O., Power House, Nov. 18	
Dec. 11. Milwaukee, Wis., Tunnel, Dec. 2	
Dec. 11. Rutherford, N. J., Street, Dec. 2	
Dec. 12. Chicago, Ill., Dec. 2	
Dec. 12. Fort Sam, Dec. 2	
Dec. 15. Washir, Dec. 2	
Dec. 16. Sr, Dec. 2	
Dec. 17, Dec. 2	
Dec. 18, Dec. 2	

Dec. 14. Wilmington, Cal., Dredging, Dec. 9	
Dec. 14. New York, N. Y., Excavation, Dec. 9	
Dec. 14. Minneapolis, Minn., Ditch, Dec. 9	
Dec. 15. Burlington, Ia., Ditch Work, Dec. 2	
Dec. 21. Webster City, Ia., Ditch Work, Dec. 9	
Dec. 22. Estherville, Ia., Ditch, Nov. 18	
Dec. 22. Albany, N. Y., Barge Canal Work, Dec. 2	
Jan. 9. Anoka, Minn., Ditch Work, Nov. 25	

Materials, Machines, Supplies, Tools, Etc.

Dec. 9. Washington, D. C., Towing Machines, Nov. 18	
Dec. 9. Chicago, Ill., Iron Working Machinery, Dec. 2	
Dec. 10. Grand Rapids, Mich., Pumping Machinery, Dec. 2	
Dec. 10. Dayton, O., Engine, Generator, Dec. 9	
Dec. 10. New York, N. Y., Cement, Dec. 9	
Dec. 10. New York, N. Y., Electric Motors, Dec. 9	
Dec. 10. Phoenix, Ariz., Scrapers, Dec. 9	
Dec. 14. Washington, D. C., Boilers, Generators, Rope, Etc., Nov. 25	
Dec. 14. San Bernardino, Cal., Water Pipe, Dec. 9	
Dec. 15. New York, N. Y., Road Roller, Dec. 9	
Dec. 16. New York, N. Y., Corporation Cocks, Dec. 9	
Dec. 17. Washington, D. C., Pipe Fittings, Etc., Dec. 9	
Dec. 18. Warren, Pa., Gas Engines, Generators, Dec. 9	
Dec. 21. National Soldiers' Home, Va., Pumps, Etc., Dec. 2	
Dec. 21. Burrwood, La., Ice Plant, Etc., Dec. 2	
Dec. 21. Washington, D. C., Boilers, Cement, Etc., Dec. 2	
Dec. 28. Washington, D. C., Lumber, Jacks, Etc., Dec. 9	
Dec. 28. Camaguey, Cuba, Pumping Plant, Dec. 9	
Dec. 31. Washington, D. C., Powder Hoists, Dec. 9	
Jan. 4. Fort Monroe, Va., Engines, Boilers, Etc., Dec. 9	
Jan. 15. Portland, Ore., Portland Cement, Dec. 2	
Feb. 22. Winnipeg, Man., Pump, Motor, Dec. 9	

BIDS ASKED

Bridges.

Bids are asked on following notes being arranged states:

B-

arches and Scherzer double rolling lift draw span, and piers and abutments and the approaches thereto.

Doylestown, Pa.—Until Dec. 21, according to reports, by County Commissioners, for constructing reinforced concrete bridge over canal at Bridge St., Morrisville.

Greenville, S. C.—Until 11 a. m., Dec. 11, by J. P. Goodwin, Supervisor, for building new bridge over Saluda River in R. Mays Cleveland bottoms, and until noon, Dec. 11, for bridge over branch near A. Mays Cleveland's Mill.

Memphis, Tenn.—Until noon, Dec. 10, by Ennis M. Douglass, City Register, for labor, materials, hauling, scaffolding and forms, and for constructing a bridge 66 ft. wide across the Southern Ry. right of way on Monroe Ave. to replace steel span at that point. Bidders will submit their own detailed plans and specifications.

Salt Lake City, Utah.—Until 8 p. m., Jan. 8, by Board Public Works, L. C. Kelsey, City Engineer, for constructing a steel or concrete highway bridge across the Jordan River at North Temple St.

Richmond, Va.—Until Dec. 12, by P. St. J. Wilson, State Highway Commissioner, Richmond, for replacing old bridge now in river at site, or for construction of new bridge, over Appomattox River between Amelia and Cumberland Counties.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Covina, Cal.—Until 1 p. m., Dec. 28 (extension of time), by G. D. Jennings, Clerk, School District, for erection of a high school building. F. S. Allen, Architect, 712 Security Bldg., Los Angeles, Cal.

Porterville, Cal.—Until Dec. 23, by J. F. Wright, Secretary Masonic Temple Association, for erection of a 3-story and basement brick building. C. K. Kirby, Jr., Architect, Fresno, Cal.

Paris, Ill.—Until 3 p. m., Jan. 6, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. Post Office at Paris.

Belle Plaine, Kan.—Until Dec. 21, by School Board, J. H. Large, Clerk, for the construction of a 2-story brick addition to the present brick school house.

National Military Home, Kan.—Until noon, Dec. 12, by Major W. M. Martin, Treasurer, Western Branch N. H. D. V. S., National Military Home, for furnishing material and labor for remodeling headquarters building.

Frankfort, Ky.—Until noon, Jan. 5, by Ed-
M. Drane, Secretary Capitol Commission, for installation of electric light fixtures in new capitol building at
H. H. Drane, Architect.

and gas piping, for State Armory at White Plains. F. B. Ware, State Architect, Albany, N. Y.

Carthage, O.—Until noon, Dec. 19, by D. L. Sampson, Secretary Directors of the Hamilton County Agricultural Society, Cincinnati, for furnishing the necessary labor and material for the erection of a grand stand and alteration and additions to the present grand stand, located on the fair grounds at Carthage. Andrew R. James, Architect, Blymer Bldg., 514 Main St., Cincinnati, O.

Cleveland, O.—Until noon, Dec. 17, by A. R. Callow, Secretary Board of Public Service, City Hall, for installing mechanical ventilating system in the Zoological Building in Brookside Park. Certified check for \$200 required with bid.

Lisbon, O.—Until 1 p. m., Jan. 4, by County Auditor, for remodeling quarters for insane at County Infirmary.

Ramona, Okla.—Until noon, Dec. 22, by School Board of School District No. 16, Washington County, Oklahoma, for the erection and completion of a high school building, according to plans and specifications on file with the Secretary of the School Board at Ramona, and in the office of Layton & Smith, Architects, Oklahoma City. Estimated cost is \$40,000.

Parnassus, Pa.—Until 4 p. m., Dec. 15, at office of Charles J. Rieger, Architect, Room 1302, Peoples Savings Bank Bldg., No. 307 Fourth Ave., Pittsburgh, Pa., for the erection of a municipal building to be erected on Main St., Parnassus.

Providence, R. I.—Until 2 p. m., Dec. 16, by Charles R. Makepeace, Chairman Committee on City Property, City Hall for constructing 12-room grammar school building on Veazie St. Clarke, Howe & Homer, Architects, 72 Weybosset St., Providence.

Moultrieville, S. C.—Until noon, Dec. 30, by Constructing Quartermaster, for constructing, plumbing, heating and electric wiring band barrack; constructing, plumbing and electric wiring four N. C. O. quarters; constructing, plumbing, heating and electric wiring lavatory for band at Fort Moultrie, S. C.

Johnson City, Tenn.—Until 3 p. m., Jan. 7, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction complete of the U. S. Post Office at Johnson City, Tenn.

Murfreesboro, Tenn.—Until 3 p. m., Jan. 9, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction complete of the U. S. Post Office at Murfreesboro.

Houston, Tex.—Until Dec. 15, by A. E. Amerman, County Judge, for furnishing and installing power, heating, vacuum sweeping system, plumbing, electric wiring and elevator for proposed Harris County court house. Lang & Witchell, Architects, Dallas, Texas.

Harrisburg, Va.—Until Dec. 17, by Board of Trustees State Normal and Industrial School for Women, Harrisonburg, for steam heating and ventilating plant, plumbing and electric wiring for dormitory and dining hall. Charles M. Robinson, 404 1/2 and Main Sts., Rich-

mond, Va.,
Until noon, Dec. 22,
for Bureau, Wash-
ington, D. C., for the
erection of an un-
derground for the
transport of Agri-

improvement of several streets by grading, paving and repaving with asphalt and granite.

New York, N. Y.—Until Dec. 15, by Allen N. Spooner, Commissioner of Docks, Pier A Battery Pl., for furnishing material and repaving asphalt pavement on North and East Rivers.

Cleveland, O.—Until noon, Dec. 17, by A. R. Callow, Secretary Board Public Service, for grading, draining, curbing and paving with brick portions of 21 streets; also for paving with dressed block Medina stone on 6-in. concrete foundation portions of two streets and for paving with tar macadam on one street.

Pittsburg, Pa.—Until Dec. 23, by F. P. Booth, County Comptroller, for improving Troy Hill Extension No. 2 road for a distance of two-thirds mile.

Pittsburg, Pa.—Until 10 a. m., Dec. 10, by A. B. Shepherd, Director Public Work, for grading, curbing and paving with standard sheet asphalt portions of six streets, for grading, curbing and paving with repressed vitrified brick an alley, for grading portion of Fisk St., and for repaving with standard sheet asphalt on portions of three streets.

New York, N. Y.—Until 3 p. m., Dec. 10, by Park Board, Arsenal Bldg., 5th Ave. and 64th St., for labor and materials for reconstructing and surfacing with asphaltic concrete that portion of Riverdale Ave. between the northerly and southerly boundaries of Spuyten Duyvil Parkway, in the Borough of The Bronx.

Houston, Tex.—Until noon, Dec. 15, by John B. Ashe, County Auditor, for paving Richmond Road.

Fort Myer, Va.—Until 11 a. m., Dec. 17, by Capt. B. B. Hyer, Constructing Quartermaster, for the reconstruction of paving and gutters around artillery stables.

Roanoke, Va.—Until Dec. 23, by R. H. Willis, City Clerk, for paving Luck Ave. with old bricks taken up from Salem Ave.; also for constructing curb and gutter on Gilmer Ave. W. B. Bates, City Engineer

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Fitzgerald, Ga.—Until 3 p. m., Dec. 15, by A. H. Denmark, Secretary Water, Light and Bond Commission, for constructing sewer system, to include about 20 miles of 6-in. to 18-in. vitrified pipe sewers. J. C. Anderson, Engineer, 504 Garbutt-Donovan Bldg., Fitzgerald.

Indianapolis, Ind.—Until 10 a. m., Dec. 11, by Board of Public Works, for construction of a main sewer in and along 30th St., Hillside Ave., Fountain St., Glen Drive and other streets from Fall Creek to Brightwood Ave.

Brooklyn, N. Y.—Until 11 a. m., Dec. 16, by Bird S. Coler, Borough President, for constructing pipe sewers in portions of 52nd and Senator Sts., 2nd Ave. and Eastern Parkway.

Muskogee, Okla.—Until Dec. 21, by L. B. Kinsey, City Engineer, for constructing brick, vitrified pipe and concrete storm sewers to cost \$250,000.

Danville, Va.—Until Dec. 10 (readvertisement), by Trustees State Hospital, Danville, for constructing sewage disposal plant. Albright & Mebus, Engineers, Land Title Bldg., Philadelphia.

Pittsburg, Pa.—Until 10 a. m., Dec. 10, by A. B. Shepherd, Director Public Works, for constructing 24-in. pipe relief sewer in 47th St.; also for constructing several 12-in. to 18-in. pipe sewers.

Redfield, S. Dak.—Until 8 p. m., Dec. 11, by T. Potech, City Auditor, for construction of main sewer.

Mont, Tex.—Until 10 a. m., Dec. 15, by G. Sutton, City Secretary, for construction of 1,055 ft. of 12-in. vitrified pipe Magnolia Ave., and 615 ft. of 8-in. pipe sewer in Caldwell St.

Wis.—Until 2 p. m., Dec. 21, by Board of Sewers, Fred F. Martin, City Clerk, for furnishing steel tubes or pipes: Dousman River, 300 ft. long, 14 in. inside diameter, 12 house connections; Fox longation of Ninth St. east-
ing, 48 in. inside diameter, connections; East Mason St. 100 ft. long, 14 in. inside diameter connections; Emily St. and long, 14 in. inside diameter.
—Until noon, Dec. 11, by Constructing sewer in Tupper
Jaw, City Surveyor.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Winterset, Ia.—Until Dec. 14, by W. R. Scott, City Clerk, for constructing water works, W. K. Palmer Co., Engineers, Kansas City, Mo.

Grafton, Ill.—Until 1 p. m., Dec. 9, by H. C. Miller, City Clerk, for constructing water works plant for this city. Richard H. Phillips, Engineer, Security Bldg., St. Louis, Mo.

Brooklyn, N. Y.—Until Dec. 17, by Park Board, Arsenal Bldg., 5th Ave., and 64th St., New York, for furnishing and laying cast iron water mains in Prospect Park.

New York, N. Y.—Until 3 p. m., Dec. 10, by Park Board, Arsenal Bldg., 5th Ave., and 64th St., for labor and materials for excavating, depositing mold, sodding and installing water supply in addition to Riverside Park.

Astoria, Ore.—Until Dec. 21, by City Clerk, for constructing 12,000 ft. of 24-in. concrete water pipe and 1300 ft. of steel water pipe.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Lewisville, Ark.—Levee Work.—Until Dec. 11, by W. L. Convey, Secretary Red River Levee District No. 1, for about 70,000 cu. yds. of levee work.

Wilmington, Cal.—Dredging.—Until Dec. 14, according to reports, by City Trustees, for improvement of harbor, the work aggregating about 800,000 cu. yds. of dredging.

Webster City, Ia.—Ditch Work.—Until noon, Dec. 21, by O. A. Cragwick, County Auditor, for constructing ditch aggregating about 17,000 ft. of 7-in. to 26-in. tile.

Minneapolis, Minn.—Ditch.—Until noon, Dec. 14, by Hugh R. Scott, County Auditor, for constructing Ditch No. 10, including a bridge.

New York, N. Y.—Excavation.—Until 3:30 p. m., Dec. 14, by C. B. J. Snyder, Superintendent of School Buildings for the general excavation, etc., Contract No. 1, of Washington Irving High School, Irving Pl.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Rutherford, N. J.—Street Lighting.—Until 8 p. m., Dec. 11, by Frank A. Stedman, Borough Clerk, for street lighting for a period of ten years.

Fort Sam Houston, Tex.—Gates, Fences.—Until Dec. 12, by L. J. G. Fleming, Constructing Q. M., for the construction of pad-dock fences, gates, picket lines and removal and rebuilding woven wire fences for new cavalry stables at this post.

Milwaukee, Wis.—Tunnel.—Until 10:30 a. m., Dec. 11, by Board Public Works, Charles J. Poetsch, Chairman, for constructing a concrete lined tunnel to carry the water main under the Chicago & Northwestern Ry.'s depressed tracks at Bradford Ave. Certified check for \$1,200 required with bid.

Hawaii.—Dry Dock.—Until 11 a. m., Feb. 13, by Bureau of Yards and Docks, Navy Department, Washington, D. C., for constructing a concrete and granite dry dock approximately 1140 ft. long, 130 ft. wide and 35 ft. deep, at the Naval Station, Pearl Harbor, Hawaii.

Winnipeg, Man.—Electric Plant.—Until Dec. 28, by Board of Control, for construction and equipment in connection with the electric power development on the Winnipeg River for the city of Winnipeg. The bids call for the construction of: (a) the general works, (b) the transmission system, (c) the steel towers, (d) the transmission cable. It is estimated the work will amount to \$1,500,000 and bidders may include or group together one or more of the various portions of the work to be done.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Phoenix, Ariz.—Wheel Scrapers.—Until noon, Dec. 10, by Board of Control, James J. Riggs, Secretary, for furnishing for use at the Territorial Prison, four 2-wheeled scrapers with capacity of not less than 17

cu. ft. of earth each. Good second-hand scrapers will be considered.

San Bernardino, Cal.—Water Pipe.—Until Dec. 14, by Water Commissioners, A. G. Kendall, Chairman, for furnishing several car loads of water pipe for repairs to city water system.

Camaguey, Cuba.—Pumping Plant.—Henry A. Young, Engineer in Charge of Water Works, advises us that bids will be opened Dec. 28 for the delivery and installation of a pumping plant for the water works of Camaguey, Cuba. The plant will consist of one triple expansion high duty pumping engine, with all auxiliaries; two water tube boilers, and one economizer. The pumping engine will be of the vertical type and will be capable of pumping 2,200 gals. per min. against a pressure of 355 ft. Further information and specifications can be obtained from Sr. D. Lombillo Clark, Director General of Public Works, Arsenal, Havana, Cuba.

Washington, D. C.—Lumber, Jacks, Etc.—Until 10:30 a. m., Dec. 28, by Capt. F. C. Boggs, General Purchasing Officer Isthmian Canal Commission, for furnishing, under Circular 483, lumber, rubber and leather holding jacks, steel, grate bars, nuts, cotter, grommets, rivets, screw plates, saws, screw drivers, soldering coppers, nippers, stone and hay forks, potato hooks, hose nozzles, oilers, lamp globes, hinges, blank books, drawing and blank paper, etc.

Washington, D. C.—Pipe, Fittings, Etc.—Until 2 p. m., Dec. 17, by Bernard R. Green, Superintendent of Construction, Office of Building for National Museum, Library of Congress, Washington, for furnishing and delivering the cut and threaded heavy pipe, fittings, valves, hangers, etc., for power room, required for the new building for the National Museum.

Washington, D. C.—Powder Hoists.—Until 11 a. m., Dec. 31, by Lt.-Col. Frederic V.

BIDS RECEIVED NOV. 30, BY BOARD PUBLIC WORKS OF LOS ANGELES, CAL., FOR CONSTRUCTING SOUTH ANTELOPE DIVISION OF THE LOS ANGELES AQUEDUCT.

	(1)	(2)	(3)	(4)	(5)
Completed and lined tunnel, 1,485 lin. ft.,....	\$37.00	\$30.00	\$30.00	\$23.00	\$26.50
Lining tunnel excavation before contract, 280 lin. ft.,.....	23.00	12.00	15.00	11.00	11.50
Canal lining with cover and backfill, 58,625 lin. ft.,.....	10.75	6.20	8.00	7.21	5.69
Excavation, 283,140 cu. yds.,.....	1.00	.40	.25	.46½	.26½
Plain concrete in culverts, 446 cu. yds.,.....	15.00	8.00	10.00	10.00	12.00
Rubble concrete, 100 cu. yds.,.....	10.00	8.00	10.00	7.00	5.00
Total	\$982,434	\$529,009	\$593,995	\$596,741	\$457,350

Abbot, U. S. Engrs., for furnishing and delivering powder hoists.

New York, N. Y.—Electric Motors.—Until 2 p. m., Dec. 10, by Park Board, Arsenal Bldg., 5th Ave., and 64th St., for furnishing and delivering seven electric motors to the American Museum of Natural History.

New York, N. Y.—Road Roller.—Until Dec. 15, by George Cromwell, President Richmond Borough, New Brighton (S. I.), N. Y., for furnishing and delivering a 10-ton steam road roller.

New York, N. Y.—Cement.—Until 10 a. m., Dec. 10, by Board of Health, Dr. Thomas Darlington, President, for furnishing and delivering, as required, 1,200 bbls. of Portland cement to the Tuberculosis Sanatorium at Otisville, Orange County, New York, during 1908 and 1909.

New York, N. Y.—Corporation Cocks.—Until 2 p. m., Dec. 16, by John H. O'Brien, Commissioner Water Supply, Gas and Electricity, 13 Park Row, for furnishing and delivering corporation cocks, as follows: 5,065 ½-in. corporation screw cocks, with tail pieces, complete; 200 ¾-in. corporation screw cocks, with tail pieces, complete; 500 1-in. corporation screw cocks, with tail pieces, complete; 250 2-in. corporation screw cocks, with tail pieces, complete.

Dayton, O.—Engine, Generator.—Until Dec. 10, by Board of Education, O. J. Needham, President, for furnishing one 125-HP. reciprocating engine and one ½-HP. turbine engine, direct connected to generator of same rating as engine, with switchboard, etc., complete, installed ready for use.

Warren, Pa.—Gas Engines, Generators.—Until 1 p. m., Dec. 18, by Building Committee of the Board of Trustees of the State Hospital for the Insane, Warren, for the furnishing and installing of two natural gas engines, generators and switchboards for electric lighting and power plant. Specifications, etc., from W. Greenland, Stewart at the State Hospital for the Insane, Warren, Pa.

Fort Monroe, Va.—Engines, Boilers, Etc.—Until 10 a. m., Jan. 4, by Capt. Ernest R. Tilton, Constructing Q. M., for furnishing

and installing two 264 HP. and one 100 HP. boilers, two 250 HP. compound engines, one 250 HP. and one 120 HP. engines, two 150 KW. and one 75 KW. generators; also all steam, exhaust steam, drip and water, suction and discharge connections, one service condenser and gauge board, two boiler feed pumps, three composite insulators, one feed water heater, one hot well and automatic pump for oil separator; also for furnishing and installing complete underground system and complete system of street lighting at Fort Monroe, Va.

Winnipeg, Man.—Pump, Motor.—Until 11 a. m., Feb. 22, by M. Peterson, Secretary Board of Control, for supply and erection of turbine pump and motor for city water works. H. N. Ruttan, City Engineer.

CONTRACTS LET.

The following contracts have been let recently:

Birmingham, Ala.—Lock and Dam. P. H. O'Brien, of Pennington, Ala., contractor for the U. S. Government locks and dams on the Tombigbee River in Alabama, has sublet Lock and Dam No. 2 to the Southern Bridge Co., of Birmingham, Ala.

Tempe, Ariz.—School Building.—C. E. Bell, Los Angeles, Cal., for erecting school building for city.

Los Angeles, Cal.—Aqueduct.—Bids were received Nov. 30, by the Board of Public Works, for the construction of the South Antelope Division of the Los Angeles Aqueduct, and on Dec. 2 the contract was awarded to P. A. Howard, Los Angeles. The bids received and the engineer's estimates were as follows: (1) standing for Henning-sen Construction, (2) for P. A. Howard, (3) for A. C. St. John, (4) for A. H. Calkins, and (5) for engineer's estimate:

In the engineer's estimate no additions have been made for contingencies or contractor's profit. To this estimate should be added \$30,000 for contractor's equipment, making the total cost to the contractor, according to the engineer's estimate, \$487,350.50. The total cost to the city, according to the engineer's estimate, would be \$595,238.50, this sum including the items given above and the following additional ones:

56,871 bbls. cement at \$1.41.....\$80,188
671,484 lbs. reinforcing steel at 3½ cts. 23,500.
280 lin. ft. tunnel excavated prior to contract

4,200.

San Bernardino, Cal.—Bridges.—Charles Sheely Co., Denver, Colo., for erecting three county bridges.

San Diego, Cal.—Bridge.—Charles Stoffer, San Diego, at \$5,600, for constructing bridge over Chollas Creek for city. Other bids received were as follows: Atlantic, Gulf & Pacific Co., \$6,137; H. G. Fenton, \$6,590; West Coast Construction Co., \$6,390; J. W. Freeman, \$7,656; Solon Bryan, \$7,345; John Engebretson, \$6,730; Willcox Wrecking Co., \$6,752.

San Diego, Cal.—Reservoir.—Brown, Marshall & Gallagher, San Diego, at \$97,467, for constructing reinforced concrete reservoir for city.

Denver, Colo.—Steel Work.—American Bridge Co., Carnegie, Pa., at about \$400,000, for the steel work on the 20th St. viaduct to be erected for this city. H. S. Crocker is Engineer in Charge.

Las Animas, Colo.—Rebuilding Water Works.—Marshall Bros., Denver, Colo., for rebuilding water works system for city.

Hartford, Conn.—Sewer.—Charles H. Sloucum, at \$1,390, for constructing New Britain Ave. sewer and at \$401 for the Southbury St. sewer.

Denver, Colo.—Dam.—Kennebeck-Quigley Co., Kansas City, Mo., for completion of Stanley Dam for the Denver Reservoir Irrigation Co.

Wilmington, Del.—Sand Filtration Plant.—Coleman Bros., 15 Court Sq., Boston, Mass., at \$257,500, for constructing covered slow sand filter plant, etc., for city.

Burlington, Ia.—Ditch Work.—Commissioners of Louisa-Des Moines Drainage District, No. 1, Hartman Engineering Co., Peoria, Ill., Engineers, have awarded contract for the work to Russell & Cook, Oakville, Ia. The bids received for this section of the work were as follows:

15-in. tile	
4 ft. to 1 ft. deep.....	\$37.00
1 ft. to 5 ft. deep.....	38.00
5 ft. to 6 ft. deep.....	40.00
6 ft. to 7 ft. deep.....	42.00
18-in. tile	
3 ft. to 1 ft. deep.....	\$48.00
4 ft. to 5 ft. deep.....	50.00
5 ft. to 6 ft. deep.....	52.00
6 ft. to 7 ft. deep.....	55.00

For Sections 1 and 2 (open ditch work) the contract was let to R. J. Phelps, Carbon Cliffs, Ia., at \$21,595. His itemized bid was as follows: Sec. 1, 200,000 cu. yds. at 9 3/4 cts., and Sec. 2, 17,460 cu. yds. at 12 cts.

Spirit Lake, Ia.—Water Works.—Des Moines Bridge & Iron Works, Des Moines, Ia., for constructing water works here.

Elkhart, Ind.—Paving.—Andrews Asphalt Paving Co., Hamilton, O., at \$15,109, for paving on South Main St. with asphalt.

Indianapolis, Ind.—Sewer.—Manley, O'Donnell & Co., at \$1.69 per lin. ft., for local sewer in Riley St., and at 74 cts. per lin. ft. for local sewer in 33d St.

Seymour, Ind.—Sewer.—De Golger & Welsh, at \$1,790, for constructing sewer in North Vine St.

Wolcottville, Ind.—Water Works.—Rickett Bros., Auburn, Ind., for installing water works here.

Beloit, Kan.—Railway Work.—Dakota, Kansas & Gulf Ry., recently incorporated with a capital stock of \$3,000,000, to construct an electric railway between Beloit and Kearney, Neb., is stated to have let the contract for construction work to the Interurban Construction Co., of New York.

Topeka, Kan.—Dike Work.—Samuel Dolman & Son, North Topeka, at \$10,132, for constructing dike system for protection of north side.

Gladstone, Mich.—Sewer.—H. J. Kruegle, for constructing 10-in. sewer in Wisconsin Ave.

Marshall, N. C.—Water Works.—The Board of Internal Improvements has awarded the following contracts for a water works system: Contract No. 1—Contract for installing approximately 1,300 ft. of 6-in. water pipe, approximately 3,000 ft. of 4-in. water pipe, ten Ludlow fire hydrants and all necessary valves, fittings, etc., to Ball, Thrash & Co., Asheville, N. C. Contract No. 2—Contract for building reinforced reservoir to be 10 ft. deep, 5 ft. long and 20 ft. wide to Colvin & Davidson, Asheville, N. C. Contract No. 3—Contract for drilling one 8-in. well to Schank & Milliron, Asheville, N. C. All work to begin at once and be completed in ninety days. The Board has not yet decided whether an air lift pump will be used or a deep well pump, and parties interested in these systems are requested to write Dudley Chiply, Secretary of Board and Engineer in Charge.

Frankfort, Ky.—Factory Building.—Coombs Lumber Co., Lexington, Ky., at \$22,000, for erecting 90x50 ft., 3-story factory building for Ford & Johnson Co., Cincinnati, O.

Duluth, Minn.—Sewer.—John R. King, at \$3,167, for sewer in Superior St.; Simon Johnson, at \$1,772, for sewer in 26th Ave.

St. Paul, Minn.—Bridge.—American Bridge Co., Ambridge, Pa., for construction of the new bridge for the Stock Yards Terminal Railway Co. across the Mississippi River at the foot of Dayton's Bluff, about one mile north of the stock yards of South St. Paul.

St. Joseph, Mo.—Sewer, Resurfacing.—Skillbred Construction Co., for constructing sewers in Districts Nos. 35, 111 and 116; E. F. Mignery, for constructing sewer in District No. 81; Young Brothers' Construction Co., for resurfacing macadam pavement on Francis St.

Asheville, N. C.—Electric Railway.—Carolina Constructing Co., Col. V. E. McBee, President, for constructing Asheville-Henderson section of Asheville & Carolina Electric Ry.

Tecumseh, Neb.—Bridge.—Ward Bridge Co., Tecumseh, for erecting 60 ft. steel bridge over Little Nemaha River.

Dayton, O.—Sewers.—W. H. Boyd, at \$1,346, for constructing sewer in Stewart St.; Paul & Kirsbner, at \$5,087, for constructing sewer in Alberta St.

Lisbon, O.—Bridge Work.—County Commissioners have let following contracts for bridge work: Central Concrete & Construction Co., Canton, O., repairing abutment of

bridge in Salineville, \$175; new bridge near the pump station in Middleton Township, \$335; repairing bridges 1500-7-8 in Salineville, \$991, \$725 and \$988; new bridge, section 35, Wayne Township, \$558. Wm. McClain of

Russell & Cook, Oakville, Ia. per 100 ft.	Burlington Const. Co., Burlington, Ia. per 100 ft.	C. M. Hartley, Salem, Ia. per 100 ft.
\$37.00	\$43.10	\$54.00
38.00	49.63	63.00
40.00	53.50	72.00
42.00	62.70	84.00
\$48.00	\$55.20	\$78.00
50.00	61.73	86.00
52.00	65.60	93.00
55.00	71.50	106.00

Lisbon, for building a reinforced concrete arch near the Burlington pump station for \$900 and repairing of abutments of a bridge near a pump station in Middleton Township, \$850.

New York, N. Y.—Borings.—Snare & Triest, 143 Liberty St., New York, at following bid for making borings for Board of Water Supply:

Land Borings.	
Sinking casing for 1-in. cores, 5,000 lin. ft.....	\$ 1.80
Sinking casing for 1 3/4-in. cores, 1,800 lin. ft.....	1.95
Sinking casing for 3-in. cores, 200 lin. ft.....	2.10
Drilling 1-in. cores where rock penetration does not exceed 50 ft., 1,400 lin. ft.....	4.12
Drilling 1-in. cores where rock penetration exceeds 50 ft., 300 lin. ft.....	3.75
Drilling 1 3/4-in. cores where rock penetration exceeds 50 ft., 9,400 lin. ft.....	4.20
Drilling 3-in. cores where rock penetration exceeds 50 ft., 300 lin. ft.....	4.90
20 days transporting drilling machines	30.00
200 hours pumping holes.....	4.50
River Borings.	
Sinking casing for 1-in. cores, 4,000 lin. ft.....	4.20
Sinking casing for 1 3/4-in. cores, 300 lin. ft.....	4.35
Sinking casing for 3-in. cores, 200 lin. ft.....	4.50
Drilling 1-in. cores where rock penetration does not exceed 50 ft., 700 lin. ft.....	9.60
Drilling 1-in. cores where rock penetration exceeds 50 ft., 1,150 lin. ft.....	9.10
Drilling 1 3/4-in. cores where rock penetration exceeds 50 ft., 300 lin. ft.....	9.60
Drilling 3-in. cores where rock penetration exceeds 50 ft., 150 lin. ft.....	9.90
General Items.	
6-in. or larger casing left in place, 300 lin. ft.....	3.00
4 1/2-in. to 5 1/2-in. casing left in place, 300 lin. ft.....	2.00
3-in. to 4-in. casing left in place, 500 lin. ft.....	1.50
2-in. to 2 1/2-in. casing left in place, 500 lin. ft.....	1.20
Total	\$105.678

Newark, O.—Sewer. J. I. Smith, at \$1,313, for constructing sewer in Hudson Ave.

Beaver, Okla.—Railroad.—T. E. Luttgerding, Wichita, Kans., for constructing Beaver Valley & Northwestern Ry. from Gage to Hooker, a distance of 104 miles.

Ontario, Ore.—Bridge.—Minneapolis Steel & Construction Co., Minneapolis, Minn., for constructing Ontario-Snake River bridge.

Eugene, Ore.—Building Work.—Welch Bros., Salem, Ore., for constructing public building here.

Reading, Pa.—Conduit. S. W. Childs and W. A. Witman, Reading, at \$40,858, for building 8,000 ft. of 60-in. reinforced conduit for Maiden Creek filter.

Wilkesbarre, Pa.—Macadamizing. Lehigh & Wilkesbarre Coal & Iron Co., at \$16,000, for macadamizing road here.

Gordon, Pa.—Lighting. Monarch Acetylene Co., Chicago, Ill., to furnish the city with light.

Harrisburg, Pa.—Sewers. Kunkel & Ensminger, at \$6,500, for constructing sewers in Beverly Pl.

Vermillion, S. Oak.—City Hall. Eric Hylen, for constructing \$20,000 city hall for this place.

Knoxville, Tenn.—Bridge.—I. M. Jones for constructing bridge over Sinking Creek west of Concord for county.

Sherman, Tex.—Bridges.—M. S. Hasle, for Bridge Co., Dallas, Tex., for three steel bridges for county.

Wichita Falls, Tex.—Railway Work.—Charles Orth, Randlett, Okla., has contract

for constructing 30 miles of the Wichita Falls, Lawton & Northwestern Ry.

Everett, Wash.—Electric Railway.—Dibble & Hawthorne, Tacoma, Wash., for construction of line of Rapid Railway Co. through this city.

Salt Lake City, Utah.—Sewer.—J. F. Johnson, at \$5,935, for constructing sewer in extension 208.

Lunenburg, Va.—Jail.—G. G. Smith for constructing county jail.

Manitowoc, Wis.—Dock Work.—Grelling Bros., Green Bay, Wis., for rebuilding docking of C. & N. W. Ry. along the lake front.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States

Bridgeport, Conn.—Bridge Commission has adopted plans for new Congress St. bridge. Bridge is to be of stone with a Scherzer rolling lift span and will cost \$250,000. Work is to be started by Jan. 1.

Wilmington, Del.—Baltimore & Ohio R. R. has had plans prepared for a reinforced concrete bridge over Brandywine Creek to be erected in connection with straightening the right of way from Shallcross Ave. to Concord Station. A. M. Kinsman, Baltimore, Md., is Engineer of Construction, B. & O. R. R.

Cedar Rapids, Ia.—I. G. Hedrick, Consulting Engineer, Kansas City, Mo., is preparing plans for new concrete bridge to be erected over Cedar River by this city. It is hoped to award the contract by Jan. 1.

Des Moines, Ia.—Engineers of Chicago, Rock Island & Pacific Ry. are stated to be working on plans for the proposed joint railway viaduct to be erected in this city at a cost of \$150,000. W. H. Petersen, Chicago, Ill., is Bridge Engineer, C. R. I. & P. Ry.

Carlisle, Ky.—Carlisle, Parks Ferry & Flemingsburg Bridge Co. has been incorporated with a capital stock of \$10,000, and proposes to construct a steel toll bridge over the Licking River near Parks Hill. The incorporators are: E. T. Beeding, of Millersburg, Ky., T. and George W. Flora, of Parks Ferry, Ky., Dr. T. E. Hutchings, Dr. Andy McIntire and Dr. J. R. McIntire, Carlisle, and J. M. McIntire, of Flemingsburg, Ky.

Hutchinson, Kan.—City Council has been asked to construct bridge over Cow Creek on Ave. E. East.

Holyoke, Mass.—City will probably begin work early next year on proposed new bridge at Ingleside to replace the present structure. J. E. Tighe is City Engineer.

Baltimore, Md.—Executive Committee of Merchants and Manufacturers Association is to appropriate \$1,000 for a preliminary survey for a bridge over the Chesapeake Bay.

Portland, Me.—Commissioners of Cumberland County may be asked to construct a \$500,000 bridge at this place.

Lewiston, Me.—Lewiston, Augusta & Waterville Ry., according to reports, contemplate building a bridge over the Kennebec River between Winslow and Waterville in order to gain an entrance to the latter place.

Grand Rapids, Mich.—L. W. Anderson, City Engineer, has completed plans and specifications for the foot bridge to be erected over the Grand Trunk R. R. bridge.

Lansing, Mich.—Ordinance will come before City Council for constructing new bridge over Cedar River at Cedar St.

St. Paul, Minn.—St. Paul Bridge & Terminal Co. proposes to construct a bridge over the Mississippi River, connecting the St. Paul union depot grounds and the South St. Paul stock yards. William Magivny, South St. Paul, Minn., is interested.

Stillwater, Minn.—City will repair old bridge over St. Croix River at a cost of about \$2,500, the work including partial new floor.

Kansas City, Mo.—A new electric railway between this city and Excelsior Springs proposes the construction of a bridge over the Missouri River at Kansas City, Mo. E. L. Morse, Excelsior Springs, Mo., is interested.

St. Louis, Mo.—Board Public Improvements, A. J. O'Reilly, President, has prepared amended plans for the proposed new free bridge at this place. The new plans give a clearance between the center piers of 620 ft., and the bridge proper, three spans long, will be 2,000 ft.; only two of the four piers are to be within the 2,000 ft. of waterway lying between the inner harbor lines.

Missoula, Mont.—Burrell Bridge & Construction Co., Oakland, Cal., at \$134,716, was low bidder for constructing Higgins Ave. bridge in this city. Next lowest bidders were Missouri Valley Bridge & Iron Works, at \$143,500, and C. G. Sheely, at \$143,750.

Dayton, O.—City Council has appropriated \$3,000 for repairing the 5th St. bridge.

Trenton, N. J.—The long discussed projection for building a bridge over the Hudson River between New Jersey and New York will probably come before the New Jersey legislature at the next session.

Pittsburg, Pa.—Pitt Bridge Co., Canonsburg, Pa., at \$227,000, was low bidder Nov. 25 for constructing the Monongahela bridge for Washington and Allegheny Counties. Other bids received were as follows: Toledo-Massillon Bridge Co., \$232,765; McTinkler-Marshall Const. Co., \$228,018; King Bridge Co., \$234,500; American Bridge Co., \$230,135; Penn Bridge Co., \$245,333; Pennsylvania Steel Co., \$245,950.

Scranton, Pa.—Grand Jury has recommended that County Commissioners construct 19 bridges as follows: Bridge in Dunmore, over Roaring Brook; bridge in Clifton, over the Lehigh River; bridge in Fell, over Wilson Creek; bridge in Fell, over Wilson Creek; bridge in Glenburn, bridge in Lackawanna Township, over Hart's Creek; bridge in Madison, over Hornbaker's Creek; bridge in Moosic, over Spring Brook; bridge in Scott, over Ball's Creek; bridge in Spring Brook, over Spring Brook Creek; bridge in Waverly, over Stone's Creek; bridge in Archbald, over Laurel Run Creek; bridge in Benton, over Wallen Pond; bridge in Covington, over Roaring Creek; bridge in Newton, over Schultsville Creek; bridge in South Abington, over the outlet to Fuller's Swamp; bridge in Lehigh, over Buckley Run; bridge in Jermyn, over Rush Creek; bridge in Blakely, over Tinklepaugh Creek, on Main St.

Greenville, S. C.—Plans have been made for erecting concrete bridge over Reedy River for city and Greenville Traction Co.

Spokane, Wash.—J. C. Ralston, City Engineer, has completed plans for a concrete bridge at Monroe St.

Sheboygan, Wis.—Plans have been about completed for new \$90,000 bascule bridge to be erected by city at Pennsylvania Ave.

Niagara Falls, Ont.—Trans-Niagara Bridge Co. will commence work this month, it is stated, on the construction of the proposed bridge over the Niagara River. With the completion of the bridge, the International Railway, Niagara, St. Catharines & Toronto Ry. and the Hamilton, Grimsby & Beamsville Ry. companies will be consolidated, and the broken links in the trolley system between here and Toronto constructed, it is said, to be near the head of the international company. Frederic Nichols, E. R. Wood and D. E. Thompson, of Toronto; Grant B. Schley, of New York; Robert L. Fryer, Henry J. Pierce and Porter Norton, of Buffalo, and Frank A. Dudley, of Niagara Falls, N. Y., are the commissioners. All those named are connected with one or more of the trolley lines, which, it is said, will consolidate.

Railroads.

Items Arranged Alphabetically by States.

Hope, Ark.—Magnolia & Gulf Ry. Co. has made proposition to this city to build its line to this place. The road will be built from Magnolia to Waldo, and preliminary survey will be started at once. S. Q. Sevier, Camden, Ark., is Secretary and Manager.

Van Buren, Ark.—Construction of a belt line railway here is proposed. J. L. Rea is interested.

Colorado Springs, Colo.—The Grand Junction Ry. Co. has been incorporated with a capital stock of \$100,000. The incorporators include Horace A. Devereux, Eugene A. Sunderlen, Thos. E. Curtin, Henry C. Hall and Frank M. McMahon.

San Francisco, Cal.—Southern Pacific Ry., W. Hood, Chief Engineer, San Francisco, Cal., is reported to have completed arrangements for purchase of necessary land on which to erect its proposed freight terminal east of the Fort Mason Government Reservation.

Pueblo, Colo.—Local press reports quote J. E. Suedaker, Superintendent Missouri Pacific Ry., at Osawatimie, Kan., as stating that the company intends to double track its line from Kansas City to Pueblo. Work is to be started at once, according to the report. The work is part of the general improvement plan which provides for the expenditure of \$10,000,000 for ten years in permanent improvements. M. L. Byers, St. Louis, Mo., is Chief Engineer M. of W.

Cuthbert, Ga.—Advices from this place state that the Georgia, Florida & Alabama Ry. is to build an extension from Cuthbert to Richland, Ga., entering Columbus, Ga., over the tracks of the Seaboard Air Line Ry. C. G. Barney, Bainbridge, Ga., is Chief Engineer.

Newnan, Ga.—Surveys have been completed between this place and Franklin for a proposed railroad, and nearly \$100,000 has been subscribed in Coweta and Heard Counties for the road. The surveys are to be extended eastward from Newnan about 12 miles where a connection will be made with A. B. & A. R. R.

Valdosta, Ga.—Application has been made for a charter for the Valdosta, Moultrie & Western R. R., which proposes the construction of a 40-mile road in Lowndes, Brooks and Colquitt Counties. The capital stock is \$100,000 and the incorporators include Frank Roberts, W. B. Conoley, John T. Roberts, W. L. Roberts, A. L. Davis, W. E. Davis, A. F. Langford, Di Ingram and J. L. Giddens, of Valdosta, and W. P. Roberts, of Jacksonville, Fla.

Beloit, Kan.—Dakota, Kansas & Gulf Ry., said to be a subsidiary company of the Union Pacific Ry., has been incorporated with a capital stock of \$3,000,000 and will build a line connecting the Western terminus of the Union Pacific at Beloit, Kan., with the Union Pacific at Kearney, Neb., a distance of 110 miles. The contract for building the road has been let to a New York company and construction will begin within a year.

St. Paul, Minn.—St. Paul Bridge & Terminal Ry. Co. has taken steps to condemn right of way for a new line of railway between the Union depot yards and South St. Paul. The company will also build an additional bridge from a point at Dayton's Bluff near the fish hatchery, running diagonally across the Mississippi River. William Magivay and J. S. Bangs, South St. Paul, Minn., of the Stock Yards Terminal Ry., are interested.

Jackson, Mich.—Reports from this city state that the Grand Trunk Ry. will shortly begin the construction of a line from Jackson to Battle Creek, passing through Marshall, thereby shortening the running time over that road from Detroit to Chicago about 40 miles. It is proposed to have the road run out of Jackson as it does now until it strikes the Rice Creek valley, and thence westward toward Marshall, keeping north of the Michigan Central and M. U. R. lines. T. T. Irving, Detroit, Mich., is Resident Engineer, Grand Trunk Ry.

Billings, Mont.—Chicago, Burlington & Quincy R. R., according to advices, from this place, is preparing to construct the proposed Frannie-Fromberg cutoff, which will lessen the distance from Billings into the Big Horn basin about 100 miles and complete several hundred miles of what is intended to become a direct line to Denver. F. T. Darrow, Lincoln, Neb., is Engineer Maintenance of Way.

Camden, N. J.—Camden Tunnel R. R. Co. has been incorporated with a capital stock of \$40,000 to construct and operate railroads. The company has been incorporated in Pennsylvania and proposes to construct a tunnel connecting Camden and Philadelphia. The incorporators are: William A. Stern, 1805 Spring Garden St.; Isaac H. Silverman, 1844 North 19th St.; Edwin Wolf, 1607 N. Broad St.; Benjamin Wolf, 1313 North St.; A. W. From, 1433 Euclid Ave.; Frank A. Barnett, 5245 Pine St., all of Philadelphia; George H. B. Martin, 419 Market St., Camden.

Klamath Falls, Ore.—Permanent surveys for the Klamath Falls-Nation line of the Oregon Eastern Ry., are under way. The line will connect with the Southern Pacific Ry. at Eugene, Ore.

Portland, Ore.—Profiles and estimates for the construction of the first section of the Central Oregon line up the Deschute River have been sent to the Chicago headquarters of the Harriman lines for approval. The estimates call for the expenditure of \$4,000,000 for building the first 100 miles of the Deschutes line. This will construct the road as far south as Madras. From Madras the line will be built south to Bend. J. P. O'Brien, Portland, General Manager of the Oregon R. R. Navigation Co., is in charge of the work.

New Castle, Pa.—Erie R. R. will probably take up work this spring of double tracking the Sharon Ry. between Pymatuning and New Castle.

Center, Tex.—Work is stated to have been resumed on the Texas & Gulf extension of the Atchison, Topeka & Santa Fe Ry. The extension will run from Zuber to Center, and will be 21.3 miles long with six-tenths grade. It will cross the Houston East and West Texas Ry. at Tenaha, connecting with the Gulf, Colorado & Santa Fe Ry. of the

Santa Fe System at Center. The contractors are J. Scott & Sons, of St. Louis. The Texas & Gulf R. R. will operate this line with its own equipment.

Temple, Tex.—Atchison, Topeka & Santa Fe R. R. has secured land in this city for its new terminal yards.

Longview, Tex.—Gulf, Colorado & Santa Fe Ry. is to begin work shortly on two extensions from this city—one to Center and Timpson and the other to Paris. C. F. W. Felt, Galveston, Tex., is Chief Engineer.

Salt Lake City, Utah.—The Tooele Valley R. R. Co. has been incorporated with a capital stock of \$1,000,000 and will build a railroad from Black Rock just west of the Gardfield Smelters to the mouth of Pine Canyon, where the new smelter for the Utah Consolidated Co. is to be built, a distance of 25 miles. The incorporators are E. P. Matthews, General Manager of the Washoe Smelter at Anaconda, Mont., President; C. F. Kelly, Butte, Mont., Vice-President; J. B. Itisue, Manager of the Utah Consolidated Secretary and Treasurer. The other directors are C. H. Repath, the Engineer of Washoe Smelter, Anaconda, Engineer, and W. H. Cayley, of Salt Lake City. Mr. Repath will have charge of the construction of the new smelter which will handle lead ores as well as copper.

Tacoma, Wash.—Reports from this city state that the contract for the tunnel here for the Oregon & Washington line of the Harriman system has been let and that work will be rushed on the local terminals. The tunnel is to be double track, 8,700 ft. long. It will have a maximum grade of 1.25 per cent, and 450,000 cu. yds. of earth will have to be removed. Included in the plans are one half-mile of steel construction and a new drawbridge. The tunnel will cost \$3,000,000 and the steel work \$2,000,000. The same road has plans for the construction of a huge tunnel across the peninsula between the Columbia and Willamette Rivers in Portland. J. P. O'Brien, General Manager Oregon R. R. & Navigation Co., Portland, Ore., is Pacific Coast Representative of the Harriman System.

Tacoma, Wash.—Surveys have been completed from the Caribou River Valley to the water front here for the Pacific & South-eastern R. R., organized early this year. Construction work is to be started shortly on temporary terminals. Among those interested in the railway are: Gen. Thomas E. Hubbard, of New York, Chairman of the Board of Trustees of the United Bankers' Association; Charles Lathrop, of Palo Alto, Cal., Manager of the investments of the Leland Stanford Estate, and A. D. Shepard, Manager of the Pacific Improvement Co.

Belington, W. Va.—Final surveys have been completed for the West Virginia Connecting R. R., which proposes the construction of a line from this place to Belington to Waynesburg, Pa., a distance of 65 miles, and construction work is expected to begin next summer. D. F. Maroney, Pittsburg, Pa., and J. V. Thompson, Uniontown, Pa., are interested.

Electric Railways.

Items Arranged Alphabetically by States

Berkeley, Cal.—Duncan McDuffie of the Mason-McDuffie Realty Co. has applied for a franchise for a street railway in the northern part of the city.

Pomona, Cal.—The Pacific Electric Co. has applied for a franchise to build a line around the east side of Ganesha Park, connecting Huntington Boulevard with the right of way north of the park.

San Diego, Cal.—San Diego & Imperial Beach Ry. Co. has been incorporated. The company has several lines of railway already under construction. G. Y. Gray, E. W. Peterson, R. B. Thomas and R. A. Smith are interested.

Atlanta, Ga.—Surveys have been started for an electric railway from Atlanta to Union City, a distance of 17 miles. It is stated that construction work will be started as soon as the surveys are completed. W. T. Roberts is President of the company. N. V. Perry and Frank Lederle, Atlanta, are the Engineers.

Eldora, Ia.—Representatives of the Iowa Electric Ry. Co. are working on the route of the proposed line from Grundy Center to this city. The projected length between the two places is 18 1/4 miles, right of way for 14 miles of which has been secured. J. F. Hardin and Amver Davis, Eldora, are interested.

Alton, Ill.—Alton, Jacksonville & Peoria R. R. Co. will have work started shortly on its proposed extension from Godfrey, the present terminus, to Jacksonville.

East St. Louis, Ill.—City Council has adopted a bill giving the Southern Illinois Traction Co. an extension of a year to finish the construction of its electric line between East St. Louis and Belleville.

Peoria, Ill.—Peoria & Galesburg Ry. Co. has been incorporated with a capital stock of \$100,000 and proposes to construct an interurban line through Peoria and Knox Counties to Galesburg, and also through Peoria and Fulton Counties to Canton. The incorporators are: D. M. Mayer, Arthur C. Black and S. F. Atwood, of Peoria; William K. Boone, Lima, O., and Homer T. Dick, Chicago. Right of way for the proposed line is being obtained and engineers have been engaged for the surveys.

Battle Creek, Mich.—Practically all of the right of way between this city and Hastings for the proposed interurban line to Grand Rapids, has been secured. A. C. Sokell and Z. F. Fowle, Grand Rapids, Mich., are promoting the project.

Jackson, Minn.—Residents of this place are considering building an interurban line between Jackson and Spirit Lake, Ia., where connection would be made with the proposed line of the Sioux City & Spirit Lake Ry.

Kansas City, Mo.—Necessary capital is stated to have been secured for the construction of the proposed electric railway from this city to Excelsior Springs. The work includes the erection of a new bridge over the Missouri River at Kansas City. E. L. Morse and Dr. W. S. Woods, Excelsior Springs, Mo., are interested.

Helena, Mont.—Local Commercial Club, W. T. Hull, Secretary, has revived the project for the construction of the proposed electric railway between Helena and Butte. Surveys for the line were made some time ago.

Asheville, N. C.—Work will probably be started the first of the year on the construction of the proposed electric railway from Asheville to Greenville, S. C. Surveys have been made and proposed route of road is from Asheville through Hendersonville, largely following the country road on private right of way from Biltmore south to Greenville, a distance of about 75 miles. The first section to be built will be from Asheville to Hendersonville and the contract for this work has been let to the Carolina Constructing Co., Col. V. E. McBee, President, C. F. White, Asheville, N. C., is Secretary of the Asheville & Carolina Ry.

Spokane, Wash.—Permanent location surveys and some construction work are to be undertaken early this year for the Okanogan Electric Ry. Co., and it is hoped to begin active construction work early in the spring. The road is to run through Okanogan County. A. M. Dewey is President, and Horace B. Skinner is Chief Engineer.

Martinsburg, W. Va.—The Berkley Traction Co., composed of capitalists of Brooklyn, Norfolk, Wheeling and New York, has been granted a franchise to construct and operate an electric trolley line over the principal streets of Martinsburg. It is also proposed by the company to construct a belt line to Winchester by way of Charles Town and Shepherdstown. This line will be more than 50 miles in length and will cost in the neighborhood of \$1,000,000. The company is under bond to commence work in Martinsburg by April 1 next.

Sewers.

Items Arranged Alphabetically by States.

Argenta, Ark.—Work will probably be commenced in January on the extension of the local sewer system.

Newport, Ark.—City may award contract early in the year for constructing a \$40,000 sewer system. Lund & Hill, Little Rock, Ark., are Engineers.

Little Rock, Ark.—City is considering constructing storm sewers in Louisiana, 3d and 2d Sts. E. A. Kingsley is Superintendent of Public Works.

Turlock, Cal.—Board of Trustees are having plans made for constructing sewer system and septic tank.

San Diego, Cal.—Mayor Forward is advocating the laying of additional sewers in the La Jolla district.

San Jose, Cal.—East San Jose is having plans made for sewer system. Preliminary surveys were finished some time ago.

Denver, Colo.—Board of Public Works has established four new storm sewers in sub-districts in North Denver. Work will be started in the early spring on the improvements which will cost about \$95,000.

Grand Junction, Colo.—Grand Junction Town & Development Co. proposes to install water and sewer system and to lay cement

sidewalks in the northeastern section of the city.

Windsor Locks, Conn.—Town may take up matter for installing a sanitary sewer system. Joseph A. Coogan is health officer.

Traer, Iowa—Town will probably install sewer system this spring.

Cairo, Ill.—City is to construct sewers in the 34th St. district to cost \$20,676.

Quincy, Ill.—Board of Local Improvements has recommended the building of the north end sanitary trunk sewer, estimated cost is \$54,000; sewer will consist of 13 blocks of brick egg-shaped sewer, 2x3 ft., and 27 blocks of pipe sewer from 30 in. to 12 in.

Goshen, Ind.—City is considering installing new sewer system.

St. Joseph, Mo.—City Council has passed ordinance appropriating \$5,000 to pay the expenses of additional engineers to help survey and construct the proposed main sewer extension for which recent bond issue of \$250,000 was voted.

Kansas City, Mo.—Plans are being prepared by James L. Darnell, City Engineer, for the proposed improvement of the sewer system from which the City Council is to determine the amount of bonds to be voted to provide for the building of a system of storm and sanitary sewers.

Niagara Falls, N. Y.—Board of Estimate and Apportionment has authorized the issuance of \$70,000 of bonds for the extension of the tunnel trunk sewer from Sugar St.

Ladysmith, B. C.—Plans and specifications for the proposed sewer system for this city have been adopted by the City Council.

Alliance, Neb.—Special election is to be held this month to vote bonds for a \$40,000 sewer system.

Reidsville, N. C.—Special election may be held in January to vote bond issue for installing sewer system.

Camden, N. J.—State Board of Health has ordered this city to cease the pollution of the Delaware River by sewage and to build a sewage disposal plant by 1913. This will necessitate the laying of an entirely new system of sewers.

Millville, N. J.—City Council will pass ordinance for construction of a sewage disposal plant to cost \$20,000.

Batavia, N. Y.—Consulting engineers have recommended the installation of a sewer system to include pumping station and 29 miles of mains. Estimated cost is \$367,000.

Shawnee, Okla.—Mayor Stearns has called an election to vote on issuing \$245,000 of bonds, of which \$20,000 will be for sewer connections and \$150,000 for storm sewers.

Wagoner, Okla.—Council Committee is making estimates on the cost of putting in sewerage.

Pittsburg, Pa.—State Health Department approved plans for sewage disposal system for the Morganza Institute of Pittsburg.

Connellsville, Pa.—Sewer System of this place is to be improved.

Brackenridge, Pa.—State Health Department has disapproved plans of this place for sewage disposal.

Harrisburg, Pa.—J. M. Ensminger will construct a \$6,000 sewer at Kunkel Tract at East Harrisburg.

Ebensburg, Pa.—State Board of Health has directed this borough to at once cease emptying its sewage into the head waters of the Conemaugh River.

West Chester, Pa.—Town voted Dec. 1st on issuing a \$150,000 of bonds for establishing sewer system. A. P. Reid is Town Burgess.

McKeesport, Pa.—Select Council has passed bill for laying sewer in Orchard St.

Hot Springs, S. Dak.—City Engineer Southward of Deadwood, S. Dak., is making surveys preliminary to installing a complete sewer system for this city.

Mitchell, S. Dak.—City is considering installing a sewer system.

Port Townsend, Wash.—City Engineer Jackson is making preliminary surveys for an eastern sewer district.

Warren, O.—The Board of Public Service has retained Alexander Potter, Consulting Engineer, New York City, to design a system of sanitary and storm sewers, and also a system of sewage disposal. The city already has a number of sewers constructed without any regard to a general plan. It is the intention to utilize as many of the existing sewers as possible. Mr. Potter will be assisted in his work by Bert C. Smith, City Engineer, who will have charge of the field work and surveys for the proposed improvements. After the plans have been prepared, the people will be called upon to vote upon the project.

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OFFICE OF THE CONSTRUCTING Quartermaster, Cheyenne, Wyoming, November 21, 1908. Sealed proposals, in triplicate, will be received at this office until 9:30 o'clock a. m. (Mountain Time), December 21, 1908, and then opened, for constructing at Fort D. A. Russell, Wyoming, buildings specified below, and for plumbing, steam heating, electric wiring and electric fixtures in buildings requiring same. Quarters for one brigadier general, three field officers, seven double captains, three double lieutenants, one bachelor officers, two double N. C. staff officers and two double cavalry barracks; four cavalry stables, one field staff and band stable, two fire stations, one guard house, two quartermaster's workshops, two coalsheds, one hayshed, two granaries, two quartermaster's store houses and two subsistence store houses. Plans and specifications can be examined at this office and full information given upon application. Plans and specifications are on file, for the inspection of bidders, in the office of: Chief Quartermaster, Department of the Missouri, Omaha, Nebraska; Department of Colorado, Denver, Colorado; Department of the Lakes, Chicago, Illinois, and at the office of the Secretary of the Builders' Exchange, St. Paul, Minn. The United States reserves the right to reject or accept any or all bids or any part thereof. Envelopes containing proposals should be endorsed, "Proposals for Constructing, etc., of Buildings at Fort D. A. Russell, Wyoming," and addressed to Captain V. K. HART, 15th Infantry, Acting Quartermaster, U. S. Army, in Charge of Construction, Room 3, Keefe Hall, Cheyenne, Wyo.

IMPROVEMENTS TO WATER WORKS.

Connersville, Ind.

Notice is hereby given that the City of Connersville, Indiana, will on the 12th day of January, 1909, at 7:30 o'clock p. m., receive proposals for the construction and leasing to said city of certain improvements and additions to the City Water Works and water supply of said city, according to specifications on file in the City Engineer's office.

All proposals to be in the form of an offer to purchase real estate on which to construct pipe lines, pumping station and other things, and to lease all of such property to the city for a term of years, not less than ten (10) nor more than twenty-five (25), at an annual rental to be specified in proposal and providing for the right of said city to purchase said property and water supply at the end of term of years for a fixed price to be therein specified.

Such proposal shall be accompanied by plans and specifications showing style of structure and machinery to be erected specified, together with the contract or lease. The lessor to guarantee the maintenance of the source and supply of water.

Proposals to be accompanied by good bond, payable to said city in the penal sum of one hundred thousand dollars (\$100,000), conditioned that said lessor will complete said additions in accordance with terms of specifications and guarantee the maintenance of said source of water supply during term of lease.

The city reserves the right to hold any or all proposals open to acceptance until one is accepted according to the method prescribed by law.

JACOB S. CLOUDS,
City Clerk.

K. L. HANSON, Engr.

DEEP WELL.

Herrin, Ill.

Sealed proposals will be received at the office of the City Engineer of the City of Herrin, Ill., for drilling and casing a deep well for the said city until December 15, 1908.

Each proposal must be made upon blank forms furnished by the City Engineer, and must be accompanied by a certified check for \$100.00, drawn in favor of the City of Herrin, Ill., without conditions, as liquidated damages that the successful bidder will enter into contract within ten (10) days.

Specifications can be seen at the office of City Engineer. The City Board reserves the right to reject any and all bids.

Proposals open at 2 o'clock p. m., December 16, 1908.

P. S.—Specifications will be mailed by writing City Engineer or City Clerk.

OFFICE OF THE QUARTERMASTER, Jefferson Barracks, Mo., November 23, 1908. Sealed proposals, in triplicate, will be received here until 11 a. m., December 22, 1908, and then publicly opened for a complete electric lighting system, consisting of the following items: Wiring buildings, constructing pole lines, furnishing electric fixtures, transformers and apparatus. Also to furnish electric current for lighting will be received. Information furnished on application. United States reserves the right to accept any or reject all bids. Envelopes containing proposals should be endorsed "Proposals for an electric lighting system," addressed to CAPT. O. W. BELL, Q. M.

MAIN SEWER

Independence, Kan.

Sealed bids will be received at the office of the City Clerk of the city of Independence, Kansas, up to 5 o'clock p. m., Dec. 15, 1908, for the construction of a Main (or General) Sewer, the estimated amount of work being as follows:

Main No. 1—

3,900 lin. ft. of trench not over 7 ft. deep.
3,465 lin. ft. of trench not over 10 ft. deep.

3,620.5 lin. ft. of 18-inch sewer.

3,744.5 lin. ft. of 15-inch sewer.

473 cu. yds. rock excavation.

25 manholes.

75 cu. yds. of concrete.

2,000 lin. ft. of 4-inch tile (sub-drains).

Main No. 2—

165 lin. ft. of trench not over 7 ft. deep.

165 lin. ft. of 10-inch sewer.

1 manhole.

Main No. 3—

695 lin. ft. of trench not over 10 ft. deep.

695 lin. ft. of 10-inch sewer.

3 manholes.

Work and materials must be in accordance with plans, profile and specifications now on file in the office of the City Clerk.

All work must pass the inspection of the Constructing and City Engineers, and must have a certificate of correctness in compliance with the plans and specifications.

Each bid must be accompanied by a certified check in sum of five (5) per cent of the total bid.

Council reserves the right to reject any or all bids.

Bids close at 5 o'clock p. m., December 15, 1908.

J. D. KRAMER,
City Clerk.

STORM SEWERS.

Muskogee, Okla.

The City of Muskogee, Oklahoma, will on December 21, 1908, receive bids for the construction of storm sewers, aggregating \$250,000. Plans and specifications may be examined at the office of the city engineer or may be obtained after Dec. 10 on payment of \$10. The work will be part brick, part vitrified pipe and part concrete. Monthly estimates in cash.

L. B. KINSEY,
City Engineer.

PROPOSALS FOR CONSTRUCTION OF barracks and quarters, and plumbing and heating and electric wiring same. War Department, office of the Constructing Quartermaster, New London, Conn., November 28, 1908. Sealed proposals for constructing one double barrack, one single barrack, two field officers' quarters, one four-set officers' quarters, two lieutenants' quarters, three double non-commissioned officers' quarters, and one double firemen's quarters, at Fort Terry (Plum Island), New York, and two double barracks, two field officers' quarters, four lieutenants' quarters, two double non-commissioned officers' quarters, and two double firemen's quarters, at Fort H. G. Wright (Fisher's Island), New York, and for plumbing, electric wiring and installing heating plants in same will be received here until 10 a. m., Feb. 10, 1909, and then opened. Proposals are desired for brick construction of all buildings and for reinforced concrete construction on bidders' plans of barracks and non-commissioned officers' and firemen's quarters. Information furnished on application. Envelopes containing proposals should be endorsed: "Proposals for Public Buildings," and addressed: "R. M. Schofield, Major, Q. M., Constructing Quartermaster, New London, Conn."

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FORT MYER, VA., DECEMBER 2, 1908. Sealed proposals in triplicate will be received at the office of the Constructing Quartermaster, until 11 o'clock a. m., December 17, 1908, and then opened, for the reconstruction of paving and gutters around artillery stables. Certified check or Surety Company's guarantee for ten per cent of the amount must accompany each bid. Plans and specifications will be furnished on application. The government reserves the right to reject any or all bids. Proposals should be indorsed "Proposals for paving and gutters," and addressed to Captain B. B. Hyer, Constructing Quartermaster.

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H. I. SPENCE, City Clerk.

BASCULE BRIDGE.

Green Bay, Wis., Nov. 14, 1908.

Sealed proposals will be received at the office of the City Clerk, Green Bay, Wis., until 2 o'clock p. m. of Monday, December 14, 1908, for the construction of a bridge over Fox river at Walnut street. Four, one hundred forty feet fixed spans, one movable span (bascule), one hundred fourteen feet. Plans on file with Engineering News, 220 Broadway, New York; Strauss Reinforced Concrete & Bascule Bridge Co., 903 Fort Dearborn Building, Chicago; City Clerk's office, Green Bay.

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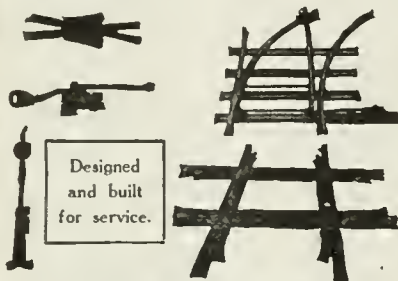
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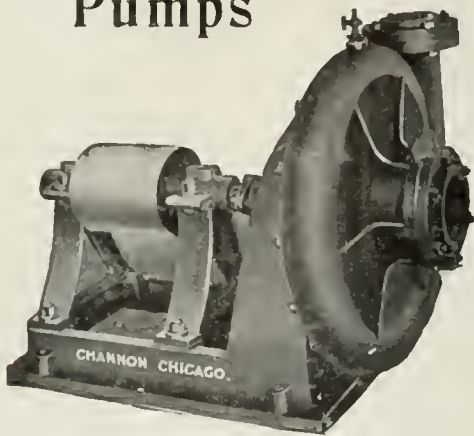
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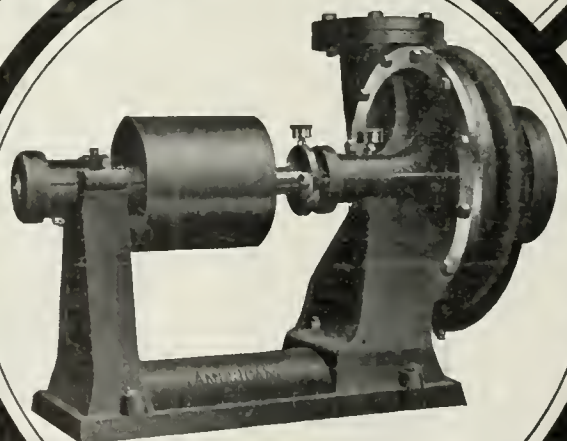
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Is It "Useless At This Late Stage to Indict the Canal Program"?

In commenting upon our Dec. 2 editorial on the excessive cost of the Panama Canal, the New York Press says that the excessive cost of that work had been "proved in the series of articles (by Lindon W. Bates) which we (The Press) published" long ago. The fact is that Mr. Bates predicted an excessive cost, but did not prove it, for, at the time his articles were written, the work had not progressed far enough to prove anything as to ultimate cost.

Aside from the matter of priority of proof—about which we care nothing, particularly since ENGINEERING-CONTRACTING antedated Mr. Bates' articles in the Press by equally well founded editorial prediction—there is a much more important feature to consider. The Press says, "It is useless and scarcely of interest at this late stage to indict the canal program because of the manner in which the expenditures have exceeded, still exceed and will continue to exceed the cost. This everybody knows. Everybody is reconciled to it, provided in the end we have a canal that can do what is required by the merchant marine and over-seas commerce, by our fleets of battle-ships and the National Defense. Until no doubt on that score is lifted, other considerations are of the slightest consequence."

Are they? Is it of the slightest consequence whether the Panama Canal shall cost \$100,000,000 more than it need cost? If so, the notorious national indifference to waste of public funds is far more pronounced than we had suspected. We have demonstrated the existence of an excessive cost, we have pointed out the cause, and we have indicated the way of stopping the loss. Is it, then, a matter of no moment whether an enormous work, scarcely begun, shall run a century of million dollars into needless waste?

The Press apparently assumes that the Panama Canal is so nearly finished that the nation had better let bygones be bygones, and fret no more about it. But, as we stated in our Dec. 2 issue, of 115,000,000 cu. yds. to be excavated by the Americans scarcely more than one-third has been taken out. On the dams and locks, estimated to cost \$55,000,000, nothing at all has been done except in the way of preparing foundations.

It is true that a large part of the Canal has been excavated, *when we take into consideration the 81,000,000 cu. yds. that the French had removed before we began.* And, by the way, that \$40,000,000 paid to the French turns out to be the best investment we have thus far made, for we got their 81,000,000 yards at 50 cts. per cu. yd., whereas our own work has cost us 80 cts.

The Press errs again in assuming that Col. Goethals has reduced the unit cost of excavation. The fact is that the work under his administration is costing more per cubic yard than it did under Stevens or

Wallace. This is no fault of Col. Goethals, but of the day labor system under which he is attempting to do the work. The average man on the payroll of Uncle Sam simply will not work with the energy with which he will work under the personal direction of a contractor. All great private corporations realize the application of this principle to their own business and do their work by contract—wherever possible. Does Harriman or Hill build a railway with "company forces?" Do the large coal mining companies excavate coal with company forces? Not where the labor unions or conditions will permit work to be done by contract.

One newspaper, in commenting upon our editorial of Dec. 2, intimates that ENGINEERING-CONTRACTING takes the stand about the Panama Canal that it does take because ENGINEERING-CONTRACTING is a contractor's paper. ENGINEERING-CONTRACTING is a periodical as much devoted to the interests of civil engineers as of contractors, a point that its name implies. It speaks, therefore, in the interest of neither class. The matter is one not to be approached with class interest in mind at all, but it devolves upon the technical press to study technical conditions and results and to pass judgment upon them. This is particularly necessary when the daily press fails to grasp the significance of technical reports. It is doubly necessary when even part of the daily press still fails to note the true import of criticism such as appeared in our issue of Dec. 2.

Certain of the daily papers have continued our criticism of the high cost of the Panama Canal as being an attack upon the Republican administration, when in fact it was simply an exposure of the inevitably high cost that occurs whenever government work is done by government forces instead of by contract. The Chicago Evening Post, for example, in its superzealous defense of the canal administration, had the following to say editorially "The enterprise is so vast that it presents a shining mark. Only last week The Evening Post reported the adverse comments upon the work of Colonel Goethals made in ENGINEERING-CONTRACTING. Their refutation by Mr. Thomas Grier Cook was prompt and effective, and the making of it was well worth while from a public standpoint."

The Chicago Post evidently refers to a letter to the editor, printed in its Dec. 5 issue, over the signature of Thomas Graham Grier, above referred to as Thomas Grier Cook. Mr. Grier, or Mr. Cook, tells of his visit to the Isthmus last February and dilates upon his astonishment at the magnitude of the work. Following which he talks about the cost records being "open to the editors of the daily papers if they wish to dig a trifle." Evidently Mr. Grier, or Mr. Cook, had dug not even a trifle himself, for he presents no statistics covering the period up to the end

at the last fiscal year, June 30, 1908, upon which the recent annual report has been made. In fact his "refutation" is the common hot air denial, accompanied by no counter analysis to show the incorrectness of our analysis of the canal expense data which, by the way, are the very data that he counsels the daily papers to investigate. We commend to the Chicago Post itself the wisdom of following that counsel of Mr. Grier, or Mr. Cook, before regarding his bare assertion as being a "refutation" of an analysis of the published records of Canal expenditures. Mr. Grier, or Mr. Cook, ends by saying: "After experiencing the climate and investigating the conditions, I desire to contradict the writer of the article you have quoted." But Mr. Grier, or Mr. Cook, discreetly rests his case there, satisfied apparently that to "experience" a climate is sufficient refutation of actual cost records, and to "investigate conditions" by riding four times across the Isthmus, qualifies him to pass judgment upon the economy with which the work has been done.

The Appraisal of Engineering Works for Purposes of Purchase, Taxation or Rate Making.

In view of the already large and growing number of engineers engaged in estimating the value of engineering plants or works, articles, like that by Mr. Leonard Metcalf on "Water Works Valuation" (printed elsewhere in this issue) are read with interest by more people than the authors may suppose. Waterworks valuation appears to be a rather narrow field of engineering, but the principles applied by the appraising engineer are essentially the same whether it be in determining the value of a waterworks, an electric light or gas plant, or a railway. Moreover, the appraisals of plants of this character are undertaken not merely to determine a fair purchasing price, where the plants are to be taken over by the public, but to arrive at fair rates for service performed, as well as to ascertain the values upon which taxes shall be levied. This last named function of the cost analysis engineer is one that is likely to be exercised far more in the future than it has been in the past. In fact, in arriving at taxable values of all kinds, even farm values, is it not the most logical plan to employ engineers who will apply the same scientific methods that are now used in appraising waterworks and railways? What, in deed, does the ordinary tax commissioner know about scientific appraisal of any sort?

Mr. Metcalf's paper contains so much that is of interest to all cost analysis engineers that we give it almost in full.

The U. S. Navy Department has awarded contracts for six submarine boats and is planning to construct two additional boats at Government yards.

Concrete and Reinforced Concrete Section

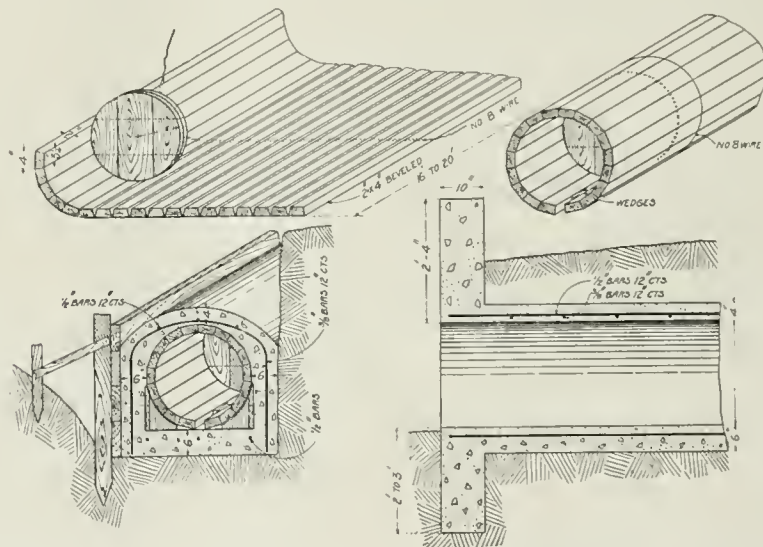
Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

A Collapsible Form for Small Concrete Culverts.

The accompanying drawings, reproduced from the second annual report of the Illinois Highway Commission, show a collapsible and an adjustable wooden form for constructing ordinary concrete culverts. The design of this form is credited to Mr. F. H. Meliza, of Farmer City, Ill., and the report states that the form has worked most satisfactorily. The construction, it is stated, is suitable for culverts from 18 ins. to 3 and 4 ft. in diameter. The form is for the barrel of the culvert only; separate end-wall forms have to be built. According to the size of the culvert, the number of staves to be used are placed side by side with a wire drawn through. They

Characteristics Required of Cements for Use in Tropical Countries.

Portland cements shipped to the Philippine Islands for use in construction there have shown certain deficiencies due to the tropical climate. The causes of these differences and their remedies have been investigated by Messrs. W. C. Reibling and L. T. Salinger for the Bureau of Science at Manila, and the results of the investigation have been reported and are published in the "Philippine Journal of Science" for June, 1908. This report is voluminous, and goes deeply into the questions of cement specifications, manipulation of cement tests, etc., and gives numerous test results. These data and discussions are not given here, but we print as a matter of decided



Collapsible Wooden Form for the Construction of Concrete Culverts.

are then rolled around a circular head which has been cut to the required size of the culvert and wire bands tied tightly around the barrel on the outside. Wedges are then driven to hold the staves firmly. After the culvert has been built, the wedges are removed and the head knocked in; the staves will then collapse, and are easily removed. Staves are made of 2x1 in. pieces of wood with their edges beveled and 2 or 3 sections used, according to the length necessary to make the culvert. It is not necessary to cut the barrel to the exact length of the culvert, as it is evident it may project beyond.

A total of 820 miles of state highway in New York was improved during the season of 1908.

interest to American cement makers and contractors the discussion on climatic influences, and the conclusions drawn from the investigation, as follows:

Local, tropical, climatic conditions must necessarily have an influence upon cement and cement testing. In the tropics, all work is done practically in the open air, being protected only from the direct rays of the sun. The climatic conditions under which cement tests or commercial work are undertaken coincide very closely with the meteorologic observations.

All the requirements of standard American cement specifications are based upon cement action characteristic of a colder climate. It would be possible, of course, to manipulate the cement testing itself in tropical countries at the temperature lim-

its specified in American standards; but this could only be done at great inconvenience and at a large expense, and furthermore it would not be practical, as the results of tests so conducted would not be true criteria of the behavior and value of the cement when used in construction work. The allowances and requirements due to the effect of the relative difference in temperature between temperate and tropical climates should therefore be taken into account in local cement specifications.

During the past year this laboratory has received a number of letters upon this subject from manufacturers, engineers, contractors, testers, and other cement workers. These either request information or make statements regarding the influence of local climatic conditions upon various phases of cement action and manipulation. A diversity of opinion has been expressed in regard to the effect of these influences by men familiar with cement work, and probably this is due to the fact that Portland cement is a very variable product, and therefore local conditions which would improve the quality of one brand would injure another, and vice versa, and during the past year our endeavor has been to secure a sufficient number of results with various brands of cement to throw some light on the effect produced by this climate on the tests.

Careful cement testing with due consideration of all conditions is of the greatest importance in a country such as this, where much of the material comes a long distance by sea, and where the rejection of a shipment means a proportionately greater loss to the dealer, owing to the cost of transportation, and also to the engineer, as construction work may be delayed. On the other hand, construction work is very expensive in this archipelago, and therefore a rigid interpretation of specifications is necessary to provide against all possibility of the use of dangerous cement.

Contrary to the general belief, the difference between local climatic conditions and those of the temperate climates exerts very little influence upon the usual standard Portland cement tests themselves. Provided the cement is of good quality, the warmer temperature prevailing here usually tends to give higher results. Of course, the fineness is not affected by it, and the specific-gravity determination is made independently of the surrounding temperature. The "accelerated soundness" tests, especially, are benefited, as the cement does not suffer as great a change in temperature; and hence expansion and warping is not so marked. Climatic conditions improve the characteristic of early tensile strength of most cements, as the variation in temperature from day to day and from hour to hour is only slight, the temperature of the water bath is higher than in cold climates, and the temperature during gaging is also higher; these are all

factors conducive to the development of high early strength. Comparative tests of both sand and neat briquettes made and preserved in the cold-storage room (17° to 21° C.), and also in the laboratory (26° to 30° C.), gave almost without exception lower results, from 3 to 10 per cent at the lower temperature. The briquettes broke more uniformly when made at the colder temperature. The difference between the strength developed under both conditions was always slight and within the limits of personal error.

However, the relatively high temperature of this climate will seriously affect the setting properties of some Portland cements. Fortunately, the setting properties of the majority of cements are only slightly influenced by this difference in temperature. It is the experience of this laboratory that high alumina cements develop setting qualities characteristic of class 2; further experimented work is necessary to determine whether this phenomenon holds true only with this class. When comparatively fresh, high-alumina cements set slowly at both temperatures, additional seasoning renders them slow setting at first at 17° to 21° , but quick setting at 29° to 31° , and finally quick setting at both temperatures.

The development of quick setting is marked by other peculiar characteristics. When the absorption of carbonic acid and combined water has progressed sufficiently, no practical amount of water which can be added will retard the rapidity of setting or eliminate the early generation of much heat, but in the earlier stages of seasoning a variation of as little as .05 per cent of water in mixing may produce a most remarkable difference in the time of the initial and final sets.

We are not prepared to discuss fully this at the present time, but the analogy to the phenomenon of the crystallization of certain salts from solution is striking. Many salts have a critical solution factor. Under slow evaporation they will remain in solution until a certain limiting percentage of the solvent has been reached, when the salt will crystallize almost instantly, heat being generated during the separation. A cement, the setting properties of which are so profoundly affected by the addition of even small quantities of water, may be said to have a critical solution (or hydration) point. We would hesitate to decide whether such a cement deserves to be approved. If tested according to the United States Army specifications it would fail to pass the setting test, but under those of the American Society the normal plasticity method will give it sufficient water to cause it to set slowly.

An engineer in these islands related an experience illustrating the practical importance of this problem. The mortar, after mixing, was dumped into a car and transported to its destination by rail in five minutes. Working with a large ship-

ment of this cement no difficulty was experienced for some time, but finally when one carload reached its destination the cement had set so hard that it was removed from the car only with much difficulty. He attributed this change to the variability of the cement, but we are inclined to believe that the water added was just sufficient to bring the cement to the critical solution or hydration point, and that a bucket or so of water less than was usually employed was used in mixing, and quick setting was the result.

Portland cement is most affected by local climatic conditions before, and not after, it is gaged. High temperature and the alternating humid and dry atmosphere are conditions under which hydration and carbonization are accelerated. In consequence, the majority of commercial products must be especially prepared to withstand tropical climates. Portland cement is very susceptible to changes under these conditions, and it is therefore essential to the best practice that cement intended for use in the tropics should develop no dangerous properties by the absorption of water and carbonic acid in normal quantities. The cement problem of tropical countries depends for its solution upon the characteristics of Portland cement; and our efforts have been to determine what class of cements are least injuriously affected by exposure and seasoning.

We believe that high-alumina cements are least efficient for use in tropical climates, although they have one laudable feature in that they never show the slightest inclination toward warping or disintegrating. Air, steam and boiling tests always develop perfect soundness. This is probably due to the fact that aluminous raw material fuses very readily at a comparatively low heat.

"Lime burned at a high heat slakes much more slowly, and is therefore more likely to be injurious than when burned at a low temperature.

"Aluminous cements gain most of their strength very quickly. 'The aluminates are thought to contribute little to the final strength of the mortar, as they are not permanent compounds, but are acted upon by various salts with which they are likely to come in contact in the work. For this reason they are not adapted for work exposed to the action of air and sea water.' 'The aluminate acts in a very energetic manner upon the set, but very little upon the hardening which is caused by the silicate of lime.* From the character of the silicates and the aluminates it is evident that the latter are acted upon more quickly and rapidly than the silicates, and it is to the crystallization of the lime from the aluminates that the initial set must be contributed. Subsequent hardening must be due to the liberation of lime from the silicates.†'"

In conformity with these quotations, it

*Spalding
†Clifford Richardson.

has been our experience with cements of this nature that the 7 to 28-day gain is small, that satisfactory 7-day breaks do not insure satisfactory 28-day strength; that 7-day strength may be even greater than 28-day; that little gain in strength takes place after 28 days, and instances are on record where the strength of the briquettes weakened after three months.

The fact that the early strength of this class of cement can not always be relied upon is probably due to its non-uniformity in burning. Owing to the fusibility of the calcium aluminate, which causes balling-up and sticking together in the hot zone of the kiln, thus preventing uniform burning, cements high in alumina are apt to be very erratic in the stability of their compounds. As a result, the rapidity with which they unite with water and carbonic acid when exposed to the atmosphere varies. The relative rapidity of the absorption of carbon dioxide and water by cements under similar conditions would therefore indicate the relative degree of low burning.

The most important characteristic of a high-alumina cement, and the one that needs the most consideration, is its susceptibility to become quick setting by exposure to the air. It has been our universal experience that Portland cements of this class containing more than 8.5 per cent of alumina always gave satisfactory results if they are tested before they have combined with more than 2 per cent of water and carbonic acid; and that when they had combined with more than 3 per cent of volatile constituents they failed to meet the setting and tensile strength requirements. It would seem as if there is something radically wrong with a cement that will not withstand atmospheric exposure to such a slight extent without developing dangerous properties, and such a cement should be rejected for use, especially in this climate.

At present we feel justified in drawing the following conclusions as being conducive to the best results and practice for all cement operations in this and similar regions.

1. We believe that the composition of Portland cement best adapted for use in tropical climate should be within the following limits

	Per Cent.
Silica	22-24
Alumina	5-7
Lime	62-65
Magnesia	0.0-4
Sulphur trioxide	1.0-2
Water and carbonic acid	0.5-3

2. "Soundness" in accelerated tests deserve special attention here, because of the prevailing high temperature. Perfect soundness is especially important for concrete works, which are exposed to the intense heat of a tropical sun.

3. "Underburning" is fatal to the efficiency of Portland cement to be used in the tropics, as the unstable compounds so

formed are most easily attacked and decomposed by the energetic atmospheric influences.

4. All "sound" cements should be protected from additional aeration as much as is practicable, as otherwise quick setting or low tensile strength is liable to be developed.

5. Sound and well-burned cements, high in silica and low in alumina, will withstand climatic influences best both before and after gaging.

6. High alumina cements give fairly satisfactory results if they are used before they develop quick setting. Quick setting is sure to develop in such cements if they are exposed to the air for any considerable length of time.

7. Samples sent to the testing laboratory should be preserved in packages which thoroughly protect the cement from the atmosphere. No accurate results consistent with the quality of the cement as it exists in the barrel at the time of sampling will otherwise be possible. Setting tests made at the laboratory before and after exposure should be insisted upon, and if quick setting develops by this additional seasoning the cement should be rejected.

The U. S. Civil Service Commission, Washington, D. C., will hold an examination on Jan. 13-14, to secure eligibles from which to make certification to fill a vacancy in the position of chemist, \$1,600 per annum, a vacancy in the position of assistant chemist at \$1,400 per annum, both at the Picatinny Arsenal, Dover, N. J., and vacancies requiring similar qualifications as they may occur in the Ordnance Department at Large.

There has been much discussion regarding the action of sea water on concrete, some claiming that there is chemical action and others that the disintegration of the surface exposed in tide water is at least largely due to frost action. In order to secure authentic data on the disintegration of concrete between tide levels, the Abertshaw Construction Co., of Boston, Mass., is about to undertake an extended series of painstaking tests on full-sized specimens. Through the permission and co-operation of the Navy Department these tests will be conducted at the Navy Yard, Charlestown, Mass., upon concrete piers made of various mixtures of concrete and of different brands of cement. These will be placed in such positions that they can be photographed at the water's edge, and so located that the base will be entirely submerged and the shaft will extend above the water. The Government is to detail an officer to record these tests, and Mr. H. L. Sherman, cement chemist, of Boston, Mass., is to make most careful analyses and records of all cement, aggregate, stone and sand entering into the work. The results of these tests will be made public.

Tests of Adhesion Between Concrete and Steel.

Some tests of adhesion between concrete and steel which are of particular interest as showing the danger of oiling or painting reinforcing rods are given in the accompanying table. These tests were made for the Rapid Transit Railroad Commission of New York City and are reported by Mr. Sverre Dahm, designing engineer, in a discussion in the Proceedings of the Municipal Engineers of the City of New York for 1907.

The tests were made with $\frac{3}{4}$ -in. and $\frac{7}{8}$ -in. rods embedded to a depth of 9 ins. in $8 \times 8 \times 12$ -in. concrete blocks. Some of the rods were deformed to give mechanical bond and others were plain, some were clean when embedded and others were rusted, painted or oiled. It will be seen from the tabular statement of results that painting or oiling the rods caused them practically to lose all hold on the concrete.

Kind of Rod.	Age in days.	Total pull, lbs.	Adhesion per sq. in., lbs.
$\frac{3}{4}$ -in. sq. rusted.....	30	11,800	437
$\frac{7}{8}$ -in. sq. clean.....	30	9,250	294
$\frac{3}{4}$ -in. sq. red lead.....	30	1,700	63
$\frac{3}{4}$ -in. sq. oil.....	30	900	33
$\frac{3}{4}$ -in. twisted clean.....	25	13,550 ¹	500
$\frac{7}{8}$ -in. sq. clean.....	30 ²	4,610	146
$\frac{7}{8}$ -in. Thacher clean.....	30	17,150 ³	700
$\frac{3}{4}$ -in. sq. graphite.....	30	270	10
$\frac{7}{8}$ -in. Thacher clean.....	30	19,450 ⁴	788
$\frac{3}{4}$ -in. twisted clean.....	25	14,030 ⁵	520
$\frac{3}{4}$ -in. sq. graphite.....	30	650	24
$\frac{7}{8}$ -in. Thacher clean.....	30	11,120 ⁶	450
$\frac{7}{8}$ -in. Thacher clean.....	30	10,200 ⁶	410
$\frac{3}{4}$ -in. twisted clean.....	30	12,330 ⁶	457
$\frac{3}{4}$ -in. twisted clean.....	30	15,190 ⁶	560
$\frac{3}{4}$ -in. sq. rusted.....	90	17,350 ⁶	642
$\frac{7}{8}$ -in. sq. clean.....	90	13,590 ⁶	431
$\frac{7}{8}$ -in. sq. red lead.....	90	3,460	128
$\frac{3}{4}$ -in. sq. oil.....	90	1,700	63

Notes: ¹ First drop at 9,000 lbs., block split; ² in water; ³ First drop at 13,910 lbs., block split; ⁴ Block split; ⁵ First drop at 6,470 lbs., block split.

The expense of operating the state railways of Chile has increased from \$5,517,863 in 1900 to \$19,282,534 in 1907.

Since 1899, when the improvement of New York highways under the supervision of the state was begun, 1,798 miles of road have been improved.

Arrangements for the second annual cement show of the Cement Products Exhibition Co., to be held at the Coliseum, Chicago, Ill., Feb. 18-24, are rapidly nearing completion. About four-fifths of the main floor space has already been taken up by exhibitors, and in order to accommodate the large number of companies desiring to exhibit, arrangements have been made for exhibits in the balcony of the Coliseum.

Decrees have been passed by the Argentine Government authorizing the construction of sanitation works in the following towns of that country: Bahai Blanca at a cost of \$600,000, Tucuman at a cost of \$1,100,000, Santa Fe at a cost of \$500,000, Corrientes at a cost of \$175,000. Water supply works are also authorized in the following towns: Villa del Rosario at a cost of \$350,000, Dorles at a cost of \$250,000, Mercedes at a cost of \$225,000.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost of Cold Springs Reservoir, Umatilla Irrigation Project, U. S. Reclamation Service.*

In the accompanying tables showing the cost of the various features of the Cold Springs Reservoir, Umatilla Project, constructed by force account, the cost of construction engineering is included under general expense and an average of about 4 or 5 per cent of the charges under general expense may properly be charged to superintendence. In Table I the cost of embankment covering the main part of the dam is made up of that of the gravel embankment, earth embankment and rockfill

pits placed with Fresno and wheel scrapers and wagons and 86,411 cu. yds. of material from borrow pits, excavated with an excavator equipped with an orange-peel bucket. Forty-six cubic yards of Class 2 material from the cut-off and drainage trenches and outlet works were wasted, although charged against embankment in Table I. About 116,600 cu. yds. of Class 1 material incidentally excavated at the gravel bank were used for the earth embankment. The cost of this portion of the earth embankment has been assumed to be the same as that for the gravel portion of the embankment owing to similarity of conditions concerning its excavation and transportation. La-

TABLE I.—COLD SPRINGS RESERVOIR.

Feature.	Quantity.	Building cost.	Engineering.	General expense.	Total cost.	Unit cost.
Embankment		\$289,756.75	.....	\$34,284.76	\$324,041.51	.....
Main spillway		28,010.11	.....	3,706.47	31,716.58	.....
Concrete, Class C, outlet, cu. yd.	712.3	10,547.91	.....	1,100.00	11,647.91	\$16.40
Concrete, Class D, cut-off walls, cu. yd.	327.1	3,742.09	.....	398.30	4,140.39	12.64
Inlet, concrete, cu. yd.	147.5	1,700.93	.....	179.00	1,879.93	12.75
Inlet riprap, cu. yd.	64.	201.60	.....	25.30	227.50	3.56
Drainage, 4", 6" and 8" tile, lin. ft.	2,937.	900.10	.....	94.80	994.90	.34
12" concrete drain pipe, lin. ft.	846.	2,862.93	.....	360.00	3,222.93	3.80
Bridge and gates, excavation and chute.		5,207.17	.....	601.20	5,808.37	.....
Feed canal, excavation and chute.		11,190.84	.....	1,186.00	12,376.84	.....
Inlet steps, concrete.	6.6	149.51	.....	29.50	179.01	27.12
Buildings		13,107.50	.....	1,467.00	14,574.50	.....
Surveys .....		.....	\$2,886.00	300.00	3,186.00	.....
Design .....		.....	1,500.00	156.00	1,656.00	.....
Cleaning up		212.60	.....	40.00	252.60	.....
Transfer of plant to Hermiston.		33,553.06	.....	722.00	4,275.06	.....
Total		\$371,143.10	\$4,386.00	\$44,650.93	\$420,180.03	.....

TABLE II.—EMBANKMENT.

Item.	Quantity.	Building cost.	General expense.	Total cost.	Unit cost.
Gravel, cu. yd.	473,400	\$151,629.94	\$17,594.24	\$169,224.18	\$0.357
Earth from gravel pit, borrow pits and spillway, cu. yd.	243,168	74,742.88	8,804.52	83,547.40	.344
Rockfill from cliff, cu. yd.	32,494	38,440.10	5,259.00	43,699.10	1.35
Excavation, Class 1, cu. yd.	34,342	8,233.05	881.00	9,114.05	.265
Excavation, Class 2, cu. yd.	6,574	7,390.57	768.00	8,158.57	1.25
Excavation, Class 3, cu. yd.	3,938	9,320.21	978.00	10,298.21	2.62
Total		\$289,756.75	\$34,284.76	\$324,041.51	.....

embankment, excavated and hauled directly therefor, and that of overhaul on 17,761 cubic yards of Class 1 excavation from the spillway. Table II shows the distribution of cost among these distributions of embankment.

The gravel portion of the embankment was excavated with a steam shovel and hauled from the gravel pit to the embankment, an average distance of a little over one-half mile. The steam shovel engineer was paid at the rate of \$6.20, the crane man \$4, locomotive engineer \$3.60, fireman \$2.40 to \$3.20 and laborers \$1.60 to \$2.40 per 8-hour day.

The earth portion of the embankment contains 40,870 cu. yds. of Class 1 and Class 2 material from the cut-off and drainage trenches and the outlet works, 17,761 cu. yds. of Class 1 material from the spillway, 22,396 cu. yds. from borrow

borers were paid at the rate of \$1.60 to \$2.40, engineers \$1, teamsters \$2.40 to \$2.60 and teams \$1 per head per horse per 8-hour day.

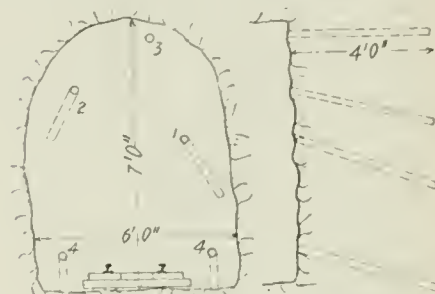
All of the rockfill portion of the embankment was obtained from a nearby rock cliff with the exception of 3,414 cu. yds. of Class 3 excavation from the cut-off and drainage trenches and the outlet works. The material used was easily blasted and was delivered to the embankment with engines and dump cars; 524 cu. yds. of Class 3 excavation from the cut-off and drainage trenches and the outlet works were wasted, although the cost thereof is charged against embankment in Table I. The rates of wages paid for this portion of the work were the same as those for earth embankment, with the exception that locomotive engineers were paid at the rate of \$3.60 and firemen at the rate of \$2.40 to \$2.60 per 8-hour day.

Methods and Costs of Driving a Tunnel With Hand Steel Holes.*

The following notes kindly furnished by Mr. Higinson, superintendent of the Hale & Norcross mine on the Comstock lode in Nevada, illustrate a rather novel and an efficient method of advancing a tunnel by the use of hand steel.

The tunnel in question was over 7 ft. high by 6 ft. wide at the bottom and was driven from near the Hale & Norcross shaft in Virginia City a distance of 6,000 ft. beneath Mt. Davidson, 4,900 ft. being driven by the method described.

The rock for nearly the entire distance was the hard diorite which composes the bulk of the mountain, being an unusually hard rock to drill and break. The cost for the entire distance averaged a little less than \$17 per ft., or \$11 per cu. yd., including wages, powder, fuse and caps. Miners received \$1 per shift and one foreman \$5. This figure also includes several days spent in repairing the mouth of the tunnel, the cost of which was not kept separate. A 15-in. air line connected to a 40-in. blower by a 15-hp. electric motor supplied air for ventilation.



Arrangement of Drill Holes.

The accompanying illustration shows the position and depth of holes and the order of firing. The back hole was always drilled first, being placed almost flat and drilled to a depth of 4 ft. Two men did the striking, using 8-lb. hammers, while another turned the steel. In the lifters only one man could strike to advantage. The steel for the starters and short lengths was 1 in., and for the longer lengths ¾ in. Bits were gaged to finish the holes from 1½ in. to 1¼ in., so as to allow the use of 1-in. powder in loading.

All the holes were completed to the required depth before blasting. If a hole became too badly fitchered to proceed with, it was given a half stick or more of powder, and the drilling continued. In this way no holes were lost. In drilling down holes, the mud was not scraped out; water being added in sufficient quantity to keep a thin mud. From 16 to 20 hours were required to complete the round of five holes to a depth of 4 ft. The hardness of the rock may be judged by these figures. As soon as a round was completed the firing of the holes commenced.

*Reprinted from the "Reclamation Record."

*Reprinted from The Mining World.

For the first firing the holes were always loaded to the muzzle. After firing, the fan was set to draw the thick smoke away from the breast, this taking about one hour. Fresh air was then forced in. Before loading the second time the holes were thoroughly cleaned out, so as to leave no loose rock to cushion the blow from the next blast. For the second round 25 sticks were given to holes 1, 2 and 3, and to the lifters 50 sticks, or as many as they would hold if less than this amount. For the third round 1, 2 and 3 were given 50 sticks each, and the lifters from 50 to 100. After the second and third rounds the smoke was drawn out from 1½ to 1¾ hours and fresh air then forced in. By this means the men always worked in good air at the breast. The third blasting nearly always broke the round to the bottom, leaving a smooth face to start the next round. Track was laid on longitudinal plank 2 in. thick, formed by one center plank 2 by 10 in., and two side plank 2 by 12 in. The back hole was lined up with the right hand crack in the plank, so that the highest part was a little to the right of the center of the drift. The air pipe was hung from hanger bolts fastened in drill holes along the back at the highest point. The forward lengths of pipe were hung so as to be readily taken down and removed on trucks before blasting.

A Practical Gasoline Rock Drill.

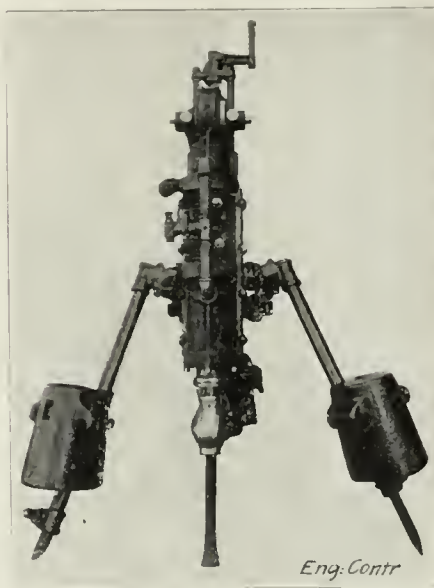
Gasoline rock drills have been invented and built by L. L. Scott, a manufacturer of gas engines at Joplin, Mo. Mr. Scott has three different types of drills, i. e., double acting hammer drill, single acting hammer "stope" drill (weight 90 lbs.), and double acting piston drill, which is illustrated in this article. The engines on all of these drills operate on the two cycle principle.

One of the early types of drill was demonstrated at the American Mining Congress last year and attracted a great deal of attention. The inventor claims the following regarding this drill: From experience in this art the requirements for a practical drill were found to be as follows: Must receive an impulse on every up and down stroke; working parts must be entirely inclosed and water tight; must be light enough so that two men can handle same; piston must be yieldingly connected to a crank shaft (free piston impossible); must be free from all valves, gears, cams and delicate parts that would not stand up under the hard usage to which it is inevitably subjected.

The drill illustrated here was built with these points in view. Its weight is 174 lbs., and it is as compact as any air drill of similar size. Will drill 3 in. per minute in hard granite rock, and will consume ⅔ of a gal. of gasoline in 15 minutes, if doing hard drilling. This drill is adapted to deep holes from 10 to 30 ft. deep, while the

small hammer drill will cut shallow holes equally as fast, with one-half the amount of gasoline.

Briefly the drill is a unique type of double acting, two cycle gas engine. The charges are drawn in through ports, at the upper and lower ends of the drill, are then compressed and passed to the central portion of the drill, where they are exploded alternately (one for the up and the other for the down stroke), and act on the inner faces of the piston, which is made of one solid piece of steel. The drill rod is swively connected to the piston, and is free to rotate independent of the piston. The rotating device is located in the lower charge receiving chamber. The crank shaft is cushioned so that there is no jar on the bearings when the bit strikes the rock. The pistons are acted on by 300 lbs. ex-



Gasoline Rock Drill.

plosive pressure. The steel is held by the usual U bolt chuck, common to piston air drills. All parts are oiled by oil that is mixed with the gasoline and drawn into the working parts at each suction of the piston. The drill as a whole permits a rigid construction and is a model of simplicity.

In underground work the exhaust is either carried (by a hose) to a waste pipe leading to the mouth of shaft or tunnel, or is run in a chemical solution (which is very cheap), and is absorbed thereby.

The advantages claimed over air drills are: Non rotating piston, which avoids the wear and friction on piston and rotating device; absolutely impossible to knock out a cylinder head; counterbalanced so that excessive vibration is eliminated; does not freeze.

Other advantages claimed for this drill are: Low cost of equipment; it can be made as cheaply as any air drill, and contains in itself the complete power plant to operate it; it will save from 50 to 80 per cent in fuel, besides eliminating the boiler, engine, air compressor, receiver, pipe lines, maintenance and depreciation of

plant and salaries of men necessary to operate power plant.

The Cost of Picking and Shoveling Hard Pan.

In a clay cut on some railroad work in Ontario Co., Ontario, Canada, some cemented gravel or hardpan was encountered. The bed of gravel lay along the bottom of the cut, and the part to be excavated was from 0.8 ft. to 4 ft. in depth. The cemented gravel was so hard that a pick, handled by an experienced man, would only enter it about 1½ ins., but the extent of the work was so small that the contractor did not feel justified in purchasing a pick pointed or rooter plow.

To excavate this hard pan with picks and shovels required 4 pickers to 5 shovelers, and 1 man was used on the dump. The extreme haul on the excavated material was 1,000 ft. At first 4 carts were used but the hauling was finished with 6 carts.

In all 500 cu. yds. of hardpan were moved at the following cost:

Loading, 1,016 hrs., at 15 cts. per hr.	\$152.40
Loosening, 817 hrs., at 15 cts. per hr.	122.55
Dumping, 101 hrs., at 15 cts. per hr.	15.15
Hauling, 513 hrs., at 18 cts. per hr.	97.74
Total	\$387.84

This gives a cost per cu. yd. as follows:

Shoveling	\$0.304
Loosening	0.245
Dumping	0.030
Hauling	0.195
Total	\$0.774

This is a high cost, although the allowance for carts per hour is small. The pickers loosened about 6 cu. yds. per day of 10 hours, while the shovelers shoveled 5 cu. yds. per day per man. This is a low record for shoveling, but as the strata of gravel was thin it was no doubt difficult to keep enough muck loosened to allow the men to get a good shovelful as they worked. Although the cost of loosening is nearly one-third of the total cost, yet the cost per cubic yard may have been reduced by using some extra pickers, thus allowing the shovel men to make a greater output.

In ENGINEERING-CONTRACTING, Aug. 19, 1908, page 117, is given the cost of excavating cemented gravel with picks, shovels and wheelbarrows, in which the cost was 35.2 cts. per cu. yd. In this case the material was blasted with light shots. This reduced the cost of loosening somewhat, but in this example a man in 10 hours loosened, shoveled and wheeled 5 cu. yds.

Wages on this job were but 12½ cts. per hour, but the cost is less than half of the Canadian example. Under the circumstances it would certainly have been advantageous to the Canadian contractor to have either blasted the gravel where it was 18 ins. or more in depth, or else bought a pick pointed plow, which would have more than paid for itself.

We are indebted to the "Canadian Engineer" for the data upon which this article is based.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Road Construction and Maintenance in Gloucester County, England.*

BY ROBERT PHILLIPS,†

This paper contains the result of the experience of the writer obtained during eighteen years direct management of 1,043 miles of main road—principally rural roads—and the supervision of some 50 miles of roads maintained by urban authorities in the county of Gloucester, England.

The county is a large one with very little waste or unproductive land, and has many industries—viz., agriculture, coal and iron mining, stone quarrying, cloth weaving and numerous other industries. The traffic on the roads, especially in some parts of the county, is heavy, as shown by the annual cost for the years 1904-5 £69,437 and 1905-6 £71,698, including bridges and improvements. The main roads of the county may be classified as follows: Worn tracks, pre-Roman roads, Roman roads, Danish roads, and constructed roads. Worn tracks are roads made by animals and afterwards adopted by man. The pre-Roman roads are composed of large quantities of gravel and are few in number. Most of the Roman roads are now buried 4 ft. to 9 ft. below the present ground level by modern deposits. When found in excavations, they appear to have been laid out in accordance with the law of the twelve tables, but in the desire for straightness, gradients were sacrificed. The Romans marched and made their roads in the open country and on hill tops. The Danes, landing in small bodies, sneaked up the valleys. They were not builders, and the roads they made were narrow, ungraded and wretched specimens of road construction.

Constructed Roads.

These roads are properly constructed roads, made under municipal by-laws, or by some public body or private individuals, and afterwards dedicated to the public.

With this introduction, this paper will follow the order of the questions to be submitted to the congress.

The Present Road.

This will be one of the descriptions of roads already described. The worn road will be found to have mostly easy gradients, but to only have a thickness of 4 in. to 6 in. of consolidated metal, and should this be fractured by excessive weight or worn by extraordinary traffic, the road becomes foundrous. This can

only be successfully remedied by gradually increasing the thickness of the metaling Constructed Roads.

These roads are constructed in three ways. After the necessary formation of the bed, if the foundation is to be of hardcore, a thickness of 12 in. of cinders, clinkers, broken brick, or hard ashes is laid and the traffic turned over it, or it is steam rolled till consolidated. On this is spread 6 in. of broken stone and 1 in. of gravel, and this is watered and rolled till consolidated.

Roads With Paved Foundations.

These roads were first constructed by Thomas Telford (the county surveyor for Salop) in 1812, have a pitched bottom of large stones 6 in. to 9 in. deep, and a broken stone coating of 6 in. of top metaling broken to measure 2½ in. in their longest diagonal dimension, and are a modification of the Roman road construction.

Later, about 1830, Edgeworth, Leahy and Macadam were engaged in constructing roads of broken stone without the paved bottom, and the last-named by persistent self-advertisement became credited as their inventor.

Except as to the lower formation of the road, there is only a slight difference between the two modes; they all specified a total thickness of 12 in. to 13 in., but Macadam made this all broken stone of equal quality composed of 1-in. cube. It may have been possible at that date with the slow traffic on broad wheels to make roads with this thickness of stone, but with the present fast traffic it is impossible, and has fallen into disuse.

The bed that the material rests on requires careful preparation. Other things being equal, the road on the plan should be straight, but straightness should always be sacrificed to the gradient, and though roads exist with gradients of 1 in 10, the angle of repose 1 in 35 should be the gradient adopted where possible. In cross section the bed should be slightly curved, giving a cross section of 1 in 30 fall from the center.

The road should never be level in the direction of its length, ditches and water courses should be located, and the roadbed inclined towards them for the purpose of drainage, the least gradient of the road in the direction of its length to be 1 in 400.

Bridges over streams are to be built preferably of stone or brick; if oblique, brick simplifies construction. Iron bridges over small streams should only be used when the headway over the water is restricted. Cross drains from the side

ditches or small water courses may be stoneware socket pipes, stone drains with cover stones, or barrel brick or stone culverts, and these should be continued through the roadside verges to the side ditches. The surface of the roadbed should be carefully examined, and any stone projecting should be removed, all portions of soft earth removed and replaced with harder material and well rammed. If there are portions of soft claylike soap, they should be trenched across and the trenches filled with ashes, cinders, gravel or sand; the trenches to be 2 yds. apart and ½ yd. deep. If the bed is boggy or wet quicksand, a coat of stiff clay over that portion and some holes sunk in the bog or sand and filled with clay will prevent the road sinking into the clay or sand, or in very bad cases 6 in. of concrete should be laid over the bog.

Choice of Coating.

If a pitched bottom of Telford's system is adopted—any hard stone, or even hard chalk may be used in 6-in. or 9-in. cubes, care to be taken that they are wedged or pinned with smaller pieces to prevent their working through the top metal. This bottom pitching, with material at 2s per cu. yd., costs about 2d per yard super. per inch of thickness. If of broken stone (Macadam's system), the whole of the 12 ins. must be of equal quality, and if carboniferous limestone costing 6s per cu. yd. delivered, and this to cover 3 sup. yds., would cost 2s per superficial yard covered. The 1 ins. of Telford's system of top metaling would require 1 cu. yd. to cover 8 sup. yds. at, say, 9d per yard. Under both systems the cost of spreading and steam rolling, and water for roller, and to consolidate the road metal has to be added. Taking the average quantity spread and consolidated per day at 30 tons, and the water at 2,000 gallons at 1s per 1,000 gallons, the cost of spreading and rolling would average 2s per cubic yard.

General Methods of Maintenance.

The manual labor on the urban roads is superintended by a road foreman and gangs of laborers, and the coatings are thicker, and the cleansing more frequent, than on rural roads. The rural roads are maintained on the district and section man system. Each district is in charge of a surveyor, and varies in size from 80 to 150 miles of main roads. These districts are divided into sections in lengths of from 3 to 6 miles, and placed in charge of a regular laborer, or section man, who is given casual laborers as his assistants when required. Team labor and the carting of material is contracted for in sections. The stone is delivered in heaps on the roadside; where the stone is carted broken there is an extra charge of 2d. to 3d. per ton, and this increases the cost considerably.

There are advantages in breaking stone on the roadside, as it keeps a certain

*A paper submitted at the First International Road Congress at Paris, France.
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amount of casual labor in a district available for harvesting, and causes a certain amount of money to be earned and spent in the district, and arrests the depopulation of the villages. Experience has proved that hand-broken stone wears longer than machine-broken. It is true that the machine-broken stone is cleaner from the screens, but with the best machines the stones are bruised or crushed, and there is 30 per cent of screenings that are sold at a loss.

In the first question answered in this paper carboniferous limestone is the only coating mentioned. There are numerous other materials, such as picked flints, from the chalk formation and oolitic limestone, but these are about the same cost as carboniferous limestone, and it would be wasteful to use the more expensive basalts or granites in the thickness required for making new roads. With maintenance it is different; most competent surveyors adopt a thickness of one stone, or 1 ton to coat 12 superficial yards as the proper coating. For a pleasant running road slightly elastic carrying ordinary light traffic a carboniferous limestone is suitable, but its life is seldom more than three years, and it is smothered with dust in summer and with mud in winter. The cost of sweeping, scraping and watering is considerable in the neighborhood of buildings. A more satisfactory coating is to always keep a skin of basalt or granite on the surface of the inferior stone; the cost of this is a little more than double the cost of limestone, but the life of the coating is from six to eight years, according to the traffic. It makes a rigid road unaffected by frost or climatic changes or acids in the atmosphere.

Spreading the Stone.

This requires a skilled workman. It should never be tipped from a cart or a barrow on the place where it has to be spread; it should never be spread or pushed into place with the back of the shovel; it should not be lifted with the shovel, and carefully placed in its position on the road. This last is the latest and most mistaken mode of application. A competent spreader takes the stone on his shovel, and spreads it with a circular motion, like the hand sower of seed, and the small and large stones drop equally in their position, and the road finishes with a true surface. The other modes of spreading result in a series of small ponds and an uneven surface.

Only as much material as can be consolidated in the day should be spread. This averages about 30 tons, and should be dry-rolled clean with a steam roller till every stone is fixed and cannot be moved by hand before any blindage is applied; blindage either of gravel or road scrapings should then be spread and watered and rolled. As little blindage as possible should be used, as it will all come off again, as dust or mud after a few days.

When stones work loose the roller should return, and dry roll the place to settle any loose stones.

The rollers used in England are of the traction engine or horizontal type, and the greatest weight of roller is thrown on the two hind rollers, or wheels. Attempts have been made by some makers to distribute the weight by throwing more on the front roller, but this prevents them traveling up a medium gradient.

There is a difference of opinion among surveyors as to the weight of rollers, and whether they should be single or compound engines. Experience has proved that the 15-ton single-cylinder roller is the best tool for the road surveyor. The constant changing of the direction of travel of the roller neutralizes any advantages of the compounding, and the small boiler of a 10-ton roller is against it, as the road engineer cannot choose the water to be used. A 15-ton roller uses one-fifth more fuel than a 10-ton roller, but does one-third more work.

Metalled roads should have a fall from the center to the sides of 1 in 30, and should be a segment of a circle in cross-section. In rural districts it should have a raised verge or margin formed by two thicknesses of turf laid, one grass side down, and the other grass side upwards. In urban districts a hard stone edge kerb 12 ins. deep and 4 ins. thick, and a flat gutter or waterway of stones or brick 9 ins. wide and 4 ins. deep, side ditches or pipe drains with gullies should be provided for drainage where streams or ditches and watercourses are not available.

Paved Roads.

In districts carrying heavy traffic granite setts 7 ins. to 9 ins. deep, 6 ins. to 7 ins. long, and 3 ins. to 4 ins. wide, are used. The steeper the gradient the narrower the setts. These are sometimes laid on a bed of gravel, but modern practice is to lay them on a bed of cement concrete 6 ins. deep and to grout them with bitumen. This is a costly but lasting form of road, but very noisy.

Wood Paved Roads.

These are generally laid on cement concrete 6 ins. thick; on this is laid wood blocks 9 ins. deep, 6 ins. to 9 ins. long, and 3 ins. wide. The modern practice is to lay these close-jointed on cement and to grout them with liquid bitumen and cover them with crushed sea shell or sharp river sand.

Wear and Dust and Cleaning.

Hardwood blocks have been used of late years, but in many cases the timber chosen has been unsuitable, and it has splintered at the edges and become uneven on the surface, and at present there is a return to creosoted fir blocks. As these have hitherto been manufactured from the soft free-grown timber from the White Sea and the Gulf of Bothnia, their life has been short. Engineers should specify that they

should be cut from the slow-growing timber of Norway and the shores of the Baltic.

This to a large extent depends on the material used for coating. In boroughs and urban districts there must be almost daily cleansing for the business of the district. In rural districts the cost of cleansing limestone roads is so great that it equals the difference in cost of the expensive basalt or granite coating. The roads should be swept in summer, as it is cheaper to get the wear off as dust than mud. Any scraping damages the road, and as little as possible should be done; the scraping should never be done across the full width of the road, only from the center to the side, as it destroys the curvature of the road. The mud should never be left in the gutter after it is dry enough to move in an ordinary cart.

Experience with 1,000 miles of road with an annual rainfall of 27 ins. proves that no watering is necessary for maintenance. In urban districts and boroughs it is necessary for the comfort of the inhabitants, for about 130 days annually, either once or twice daily, using about $\frac{1}{2}$ gals. of water per super. yd.

In the years 1832 to 1838 tar-macadam was used in several districts, and afterwards fell into disuse. With the advent of motor cars it has been revived in several ways, such as tarred stone or slag laid a depth of 4 ins. to 6 ins. This is an expensive process, as it necessitates the reconstruction of the upper surface of the road. Of the temporary applications to reduce the dust nuisance there are several, such as tar spraying and tar painting, and the application of chemicals mixed with the watering, all more or less makeshifts. The flakes of black dust that are often blown into shops and mayhap settle on the cheek of beauty do not recommend these experiments. The Gladwell system of placing tarred gravel on the old road surface and putting a clean granite or basalt coating on this and finishing it in the usual way is the least objectionable and inexpensive.

The Future Road.

With the advent of mechanically-propelled vehicles the necessity for wider and straighter roads has arisen. Whether this shall be by improving the present roads, or, as regards the main roads, purchasing land and constructing roads to be used only for mechanically-propelled traffic, is the problem.

We will consider the future road as the old road improved and made suitable for the new traffic.

The road engineer has a difficult problem, as there are two classes of mechanically-propelled machines, each requiring a different road surface. Traction engines, and what are termed light locomotives, but weighing as much as a traction engine, all with rigid iron-shod wheels, require a different surface to the luxurious motor

car with its pneumatic tires. Nothing but granite setts will withstand the constant traction traffic. An old engine attempting to draw weights beyond its horsepower will dig a hole, when the wheels fly around, in the best macadam surface. A smooth basaltic or granite macadam road is the ideal road for rubber-tired motor cars. There is only one condition suitable for both. The cross-section must be as flat as possible to prevent side-slip, and this is not detrimental to horse traffic, but renders drainage difficult. All curves should have a radius sufficient to enable approaching vehicles to be seen round the curve. If the junctions of the roads are in cuttings, the banks should be lowered on the inner curve for the same purpose. All roads joining at right angles should be trumpet-mouthed at their junctions. The margin of the metalled surface should be kept low and no tree should be planted on the road side of the fence, as they are dangerous in case of accidents.

The Blome Method of Constructing Concrete Pavements.*

Taking as its text the problem of supplying a pavement that would meet the demands of the changing traffic and conform to existing sanitary requirements, the Rudolph S. Blome Co. of Chicago and New York has evolved methods of its own in a treatment of concrete. The method is not a creation, it is a development, and is the result of experiments covering a period of about 12 years. The Blome pavements have been laid under every climatic condition peculiar to the United States. In Calumet, Hancock and Houghton, Michigan, where the thermometer frequently reaches 40 degrees below zero during the winter months and often ascends to 90 degrees above during the summer season, pavements have been down for three years without indicating any evidences of fracture or disintegration due to any action of the weather. What is true of this extremely cold climate is likewise true of the warmer localities where these pavements have been in use in southern cities for a similar period of time without showing any deterioration caused by the elements. In the city of Chicago pavements have purposely been laid in localities where the heaviest traffic conditions prevail and after a period of from five to twelve years of constant use show comparatively slight traces of wear and little or no tendency to break or chip; the top levels have been almost perfectly maintained and at the expiration of the guarantee period, the pavements have invariably been turned over to the owners in almost as good condition as they were when first laid.

The Blome methods have taken into account the skidding tendencies of rubber tired vehicles and a wise provision has been

made to avoid this dangerous inclination of this class of traffic. By a careful treatment of the surface of the pavement immediately following the laying of the work ample provision is made to prevent this troublesome difficulty and the results have been highly successful.

The specifications for the Blome system of granitoid concrete blocked pavement are as follows:

FOUNDATION: The ground shall be brought to a level 11 ins. below the final level of the pavement, and then there shall be placed a layer of coarse sand or cinders 4 ins. in thickness. This filling is to be rolled to a true surface, so that the granitoid concrete blocked pavement will be of uniform thickness throughout. The contractor must use necessary precaution in preparing the sub-grade so as to support the pavement permanently, and so that the pavement shall remain at the original grade for a period of five years. This clause will not be waived on account of any trenches or holes made in the street prior to the laying of the pavement by any corporation or private party.

All the slopes which shall be given to the street pavement shall be made in the foundation, so that the concrete work will be of uniform thickness throughout. The foundation shall be carefully compacted either by a steam roller or other suitable means at the discretion of the engineer. Then the concrete shall be put in place in the manner specified.

MATERIALS: Cement—Portland cement shall be used and, ordinarily, will be subjected to the following inspection and tests:

Soundness: It shall meet the requirements of the "boiling" test.

Setting: The cement when mixed with 20 per cent of water by measure shall take the initial set in not less than 45 minutes.

Strength: Briquettes, 1 in. square in section, shall develop the following tensile strength:

Neat (one day in air and six days in water), 400 lbs. A mixture of one part cement to three parts sand (one day in air and six days in water), 175 lbs.; it shall show a gradual increase in strength of 15 per cent at the end of 28 days.

Sand: All sand shall be clean, dry, free from dust, loam and dirt; of sizes ranging from $\frac{1}{8}$ in. down to the finest, and in such proportion that the voids, as determined by saturation, shall not exceed 33 per cent of the entire volume. It shall weigh not less than 95 lbs. per cubic foot. No wind drifted sand shall be used.

Stone: All crushed stone used in making the concrete shall be of the best quality of limestone or trap rock; clean, free from dirt, broken so as to measure not more than $1\frac{1}{2}$ ins. and not less than $\frac{1}{4}$ in. in any dimension. The stone when delivered on the street shall be deposited on flooring and kept clean until used.

MIXING AND LAYING CONCRETE: The

pavement shall consist of $5\frac{1}{4}$ ins. of concrete base, and surface blocking $1\frac{3}{4}$ ins. thick, making a total of 7 ins. exclusive of foundation.

After the sub-grade and foundation have been prepared as specified, there shall be deposited concrete composed of one part Portland cement, three parts sand and four parts crushed stone. These materials to comply with the requirements above noted, and shall be mixed by a machine suitable for the purpose, to be approved by the engineer. It shall be mixed at least six times before being removed from the mixer. The concrete shall be thoroughly tamped in place, and shall be $5\frac{1}{4}$ ins. thick at all points after having been compacted. It shall be laid in sections with expansion joints (all as per the Blome Co.'s patents) and shall follow the slopes of the finished pavement, so that the surface blocking shall be uniformly of the same thickness at all points.

SURFACING: After the concrete base has been placed, and before it has begun to set, there shall be immediately deposited thereon the granitoid blocking, which shall be $1\frac{3}{4}$ ins. thick. It will contain one part of Portland cement and one and one-half parts of clean, monument, crushed granite or trap rock. This granite shall be screened, with all dust removed therefrom, utilizing the following composition of this material: 50 per cent of the granite to be of what is known as $\frac{3}{4}$ in. size, 30 per cent of the $\frac{1}{2}$ in. size and 20 per cent of the $1/16$ in. size. This proportion of sizes is essential, and must be kept absolutely accurate, as in this lies one of the essential requirements to produce proper results. This material to be mixed with the cement thoroughly, and after being wetted to a proper consistency and deposited on the concrete, shall be worked into brick shapes of approximately $4\frac{1}{2} \times 9$ ins., with rectangular surface similar to paving blocks. This will be done by special methods, and utilizing grooving apparatus as employed under the Blome Co.'s patents.

EXPANSION JOINTS: Expansion joints must be provided across the pavement at distances not exceeding 75 ft. apart, and longitudinally, continuously along the curb and gutter. These expansion joints shall extend through the blocking and concrete, and shall be filled with a composition especially prepared for the purpose.

The specifications are modified to suit local conditions and requirements.

Nearly 18,855,090 bbls. of oil were consumed by the railways of the United States, according to a report of the U. S. Geological Survey. This is an increase of over 3,000,000 bbls. above the amount used for the purpose during the preceding year. It is estimated that 15,593 miles of railway were operated by the use of fuel oil. The total mileage by oiling burning locomotives is estimated at over 74,000,000.

*From a paper by Mr. Harry S. Dewey, read before the 15th Annual Convention of the American Society of Municipal Improvements, Atlantic City, N. J., Oct. 20, 1908.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Cost of Pumping from Wells for the Irrigation of Rice for Eighteen Pumping Plants in Louisiana and Arkansas.

The greater part of the land devoted to the growth of rice in Louisiana and Texas is irrigated with water raised from streams by large pumping plants and supplied to growers under contracts, the usual rate being one-fifth of the crop. The general provisions of these contracts are as follows: A canal company agrees to furnish a sufficient supply of fresh water for a described tract of land, but is not liable for damage on account of shortage. The water is distributed by the company, which has full control as to the manner of distributing water both to and upon the land and is to be the sole judge of the time when water should be supplied. If the planter wastes water from any cause the company may shut off the supply without forfeiting its right to one-fifth of the crop. In case of sufficient rainfall to mature a crop and the planter draws little water from the company the latter is still entitled to its share of the crop. While the extreme case just cited is never realized in actual practice, the fact remains that the demand for water varies greatly with different seasons.

In part to avoid the provisions of these contracts and have an independent supply and in part to cover lands not reached by the large canals, many growers have put down wells and installed their own pumping machinery. During the season of 1907 a number of these plants were tested by Prof. W. G. Gregory, of Tulane University, New Orleans, La., and the results of these tests are reported in Bulletin 201, Office of Experiment Stations, U. S. Department of Agriculture. Each of the 18 plants reported on is described in some detail and full test data are given for each; this article summarizes the results merely.

The tests were made to determine the cost of the water supplied and in general the efficiency of the methods and machinery used. "In making the tests the following observations were taken where practicable, exceptions being noted in the descriptions of individual tests: (1) Amount of fuel used; (2) the amount and temperature of water fed to the boilers and the steam pressure; (3) the indicated horsepower of the engine, obtained from the indicator cards and revolutions per minute of engine; (4) the height through which the water was lifted, as nearly as this could be determined; and (5) the volume of water pumped per unit of time. The cost of

fuel was also obtained, and in some cases numerous other readings of minor importance were taken; they are given in the logs of tests.

The specific gravity of the fuel oil was taken with a hydrometer. Fuel oil is bought on a basis of measurements of 42 gallons per barrel, no correction being made for differing temperatures. In most cases the oil was measured in carefully calibrated barrels. In a few instances it was measured by the fall in level in a cylindrical tank. Three hundred and twenty pounds were used as one barrel."

"The height through which the water was lifted was obtained by direct measurement. In the test of well plants the head used was the distance from the level

ing per acre irrigated. No data showing the cost of attendance and other labor employed in pumping were collected. This is considerable, as the plants are operated night and day for sixty to one hundred days each year, taking practically all of the time of two men, who receive from \$1.50 to \$2 per day. This makes an average cost of perhaps \$3.50 per day for attendance. Assuming an average season of eighty days makes this cost \$280 for each plant. In each case this sum is divided by the number of acres, to secure the cost of attendance per acre."

"Interest is assumed at 7 per cent, and depreciation at 10 per cent of the first cost. Interest, depreciation, attendance, and fuel cost for 1.25 acre-feet, or 15 acre-inches, are added to secure the annual cost of pumped water per acre irrigated."

"The tests cover a wide range of territory with varying conditions as regards lifts, types of pumps, and kinds of fuel used. The fuels used were wood, coal, and crude oil, the oil being used in Louis-

TABLE GIVING SUMMARY OF RESULTS OF TEST OF WELL PUMPING PLANTS.
LOUISIANA.

Plant. No.	Lift.	First cost.	Area irrigated.	First cost per acre irrigated	Fixed charges per acre irrigated	Fuel cost per acre irrigated	Attendance per acre irrigated	Total annual cost per acre irrigated
2.....	17.50	\$2,668	140	\$19.06	\$3.33	\$2.03	\$2.00	\$7.36
3.....	23.86	2,200	300	7.33	1.24	2.93	.93	5.10
4.....	27.00	4,404	230	19.15	3.26	4.25	1.22	8.73
5.....	33.25	3,300	175	18.86	3.21	1.78	1.60	6.59
6.....	21.00	2,500	140	17.86	3.04	2.68	2.00	7.72
7.....	7.81	2,524	165	15.30	2.00	2.34	1.71	6.85
8.....	6.27	3,500	200	17.50	2.98	2.35	1.40	7.73
Total & aver.	19.53	\$21,096	1,350	\$15.63	\$2.66	\$2.56	\$1.45	\$6.67

ARKANSAS.								
Plant. No.	Lift.	First cost.	Area irrigated.	First cost per acre irrigated	Fixed charges per acre irrigated	Fuel cost per acre irrigated	Attendance per acre irrigated	Total annual cost per acre irrigated
9.....	27.60	\$1,800	45	\$40.00	\$6.80	\$2.90	\$6.22	\$15.92
10.....	35.80	2,100	92	22.82	3.88	2.88	3.04	9.80
11.....	37.50	3,350	110	30.48	5.18	4.46	2.55	12.19
12.....	29.60	1,939	72	26.93	4.58	3.13	3.89	11.60
13.....	51.30	2,963	100	29.63	5.03	2.78	2.80	10.61
14.....	36.80	3,241	240	13.50	2.30	3.63	1.17	7.10
15.....	34.20	2,200	115	19.13	3.25	5.60	1.87	10.72
16.....	32.00	1,600	70	22.86	3.89	5.44	4.00	13.33
17.....	51.00	2,205	80	27.56	4.69	8.01	3.50	16.20
18.....	55.00	3,500	55	63.64	10.81	6.01	5.10	21.92
Total & aver.	39.80	\$24,898	979	\$25.43	\$4.32	\$4.43	\$2.86	\$11.61

at which the water stood in the discharge pipe or suction pipe while the pump was not in operation to the point to which the pump elevated it. In some cases the pumps had been running for several days and were stopped only long enough to measure the head, in one case the head was measured before and after the test, while in others the pumps had not been running for some time and the measurements were made before starting. In all cases, except those in which the pumps had not been running for several days, it is probable that the measurements show very closely the actual lift."

"In general, the tabulated results are self-explanatory. The attempt is made to bring out the facts of greatest interest to the owners of pumping plants, and especially the cost of pumping. Measurements covering several years show that the average quantity of water used on rice is about 15 inches in depth over the land during the growth of a crop, and this depth has been used in computing the cost of pump-

ing in Louisiana only. Assuming that rates of interest and depreciation are the same and that the same quantity of water is required in the two sections—1¼ acre-feet per acre for the season—and that the cost of attendance is uniform, the total cost per acre irrigated may be compared. In the accompanying table the cost of pumping in the two districts is summarized."

"The table shows that the average cost of pumping at the well plants tested in Louisiana is \$6.67 per acre while that at the Arkansas plants is \$11.61 per acre irrigated. The average lift at the Louisiana plants is approximately 20 ft., and at the Arkansas plants approximately 40 ft., the increase in cost not being quite proportional to the increase in lift. Although the Arkansas rice planters secure their water supply at a slightly smaller cost per acre per foot of lift, yet they must contend against a considerably higher cost of water than that borne by the Louisiana planters, due entirely to the increased lift."

"Coming to the comparison between taking water from a canal company in Louisiana and installing and operating a pumping plant large enough for a farm of ordinary size, in discussing this matter in a former report* the writer said, in substance: 'Assume an 8-barrel crop and that the average price of rice is \$3 per barrel. In case water is taken from a canal system, the charges of the canal company will be $1/5 \times 8 \times \$3 = \$4.80$ per acre. With rice selling at \$2.50 per barrel the amount paid the canal company would amount to \$4. When the farmer raises a 10-barrel crop, and the price is \$3 per barrel, the cost will be \$6, while if the price of rice is \$2.50, the water for the 10-barrel crop will cost \$5.' The average cost of pumping per acre in Louisiana, as shown by the table, is \$6.67. This is based on the pumping of $1\frac{1}{4}$ acre-feet per acre. If more water is used the cost will be approximately 32 additional per acre-foot used. It appears, then, that under ordinary conditions there is a slight financial advantage in securing water from a canal. Under abnormal conditions there are advantages on either side, and it is a matter of balancing these. In years of heavy rainfall and good crops the canal company secures its share of the crop for a minimum of service. Under the same circumstances the owner of a pumping plant saves his fuel charges. His interest is the same and his depreciation is nearly as great as in years when his plant is in full operation. On the basis of the plants shown in the table, the cost, if no pumping is done, will be \$2.66 per acre, and the owner would gain the difference between this and the payments to the company. On the other hand, in case of crop failure for any reason, there are no payments to the canal company, while the cost to the pump owner will still be \$2.66 per acre in addition to whatever is spent for fuel and attendance. This comes at a time when he has no crop from which to meet it, while the increased payments to the canal company come at a time when he is best able to bear them.

The Hawaiian Dredging Co., Ltd., of Honolulu, was the lowest bidder Dec. 1 for dredging approximately 5,017,600 cu. yds. of material in the channel leading from the Pacific Ocean to the site of the proposed U. S. naval station at Pearl Harbor, H. I. The company offered to complete the work for \$3,560,000, or about 70 cts. per cubic yard. The channel will be 600 ft. wide and 35 ft. deep.

The Civil Service Commission of the city of Chicago, Ill., will hold an examination at its office, 117 Market St., at 9 a. m., Dec. 22, for engineering draftsmen, Grade VI. The scope of this examination will be: Mathematics, technical knowledge, experience and a report upon an assumed state of facts.

*U. S. Dept. Agr., Office of Experiment Station, Bul. 183, p. 65.

Waters-Works Valuation and Fair Rates in the Light of the Maine Supreme Court Decisions in the Waterville and Brunswick Cases.*

BY LEONARD METCALF, M. AM. SOC. C. E.

Eleven years ago a timely paper by Wynkoop Kiersted, M. Am. Soc. C. E., upon the "Valuation of Water-Works Property,"† and the very interesting discussion which followed it, shed much light on this important question, which was the outgrowth of a well-defined movement toward municipal ownership of water-works.

Since that time many plants have been taken by the municipalities which they were serving, and some noteworthy legal battles have been fought under the leadership of lawyers of unusual ability, assisted by experts in this field of engineering. In the course of this litigation the courts have handed down some important decisions, from among which two opinions, covering the broad legal and economic works valuation and rating, stand out in bold relief. These two opinions, rendered by the Supreme Court of Maine to guide two Boards of Appraisers in their valuation of certain water-works properties, were veritable beacons in the uncertain sea of public service corporation valuation and rating, and, with their application in three recent Maine cases and certain rulings in one of these—the Portland valuation case (by the tribunal upon which sat Judge Savage, the writer of the Maine opinions referred to, and one of his then Associate Justices, Judge Powers)—furnish the text for this paper.

THE WATERVILLE OPINION.

The opinion of Judge Savage, of the Supreme Court of Maine, in "Kennebec Water District vs. City of Waterville and others, Kennebec opinion, December 27, 1902," delivered in accordance with an act of the Legislature in advance of the taking, by the Kennebec Water District,* of the plant of the Maine Water Company (supplying the City of Waterville and the Towns of Winslow, Fairfield, and Benton), laid down for the first time instructions to appraisers—upon the law of eminent domain as applied to such cases, upon the considerations which should govern them in their determination of the value of the water-works plant taken, and upon damages, and upon evidence—instructions which may be said to have become classic, so often have they been quoted by counsel in water-works valuation cases, and so large a part have they played in the trial of such cases.

Good and helpful as was the Waterville decision, however, it was so vague and am-

biguous, in its discussion of the interrelation of value and fair rates, as to leave the student in an endless circle of reasoning and a labyrinth of doubt as to its meaning upon this point. It held that:

"The property to be taken, both plant and franchise, are to be appraised, having in view their value as property in itself and their value as a source of income. There are those elements of value, but only one value of one entire property is to be appraised in the end. These elements necessarily shade into each other." (97 Maine, 185, Par. 27.)

"In addition to structure value, the appraisers should allow just compensation for all the franchises, rights and privileges to be taken." (Par. 22.)

"In estimating even the structure value of the plant, allowance should be made for the fact, if proved, that the company's water system is a going concern with a profitable business established, and with a present income assured and now being earned." (Par. 19.)

"The value of the franchise depends upon its net earning power, present and prospective, developed and capable of development, at reasonable rates; and the value to be assessed is the value to the seller and not to the buyer." (Par. 23.)

Note the last statement that "the value of the franchise depends upon its net earning power, * * * at reasonable rates * * *." As to the latter, Judge Savage says:

"The basis of all calculation as to the reasonableness of rates to be charged by a public service corporation is the fair value of the property used by it for the convenience of the public." (97 Maine, 185, Par. 3.)

"The * * * Water Company is a quasi-public, or public service corporation, and is entitled to charge reasonable rates for its services, and no more." (Par. 2.)

Thus Judge Savage appeared to hold that the franchise value depended upon the reasonableness of the rates, and that the reasonableness of the rates must depend (among other things) upon the franchise value. First, determine the fairness of the rates, and then the franchise value; but before one can determine the fairness of the rates, one must determine the franchise value (as the rates are to be based upon the entire value including franchise); and before one can determine the franchise value one must determine the reasonableness of the rates. The very hypothesis begged the question. How could the mystic circle be broken?

In referring to this opinion as being, in the above-mentioned respect, "vague and ambiguous," the writer has used the words advisedly for the reason that Judge Savage did appear nevertheless to have in mind

*Somewhat condensed from a paper presented Dec. 2, 1908, before the American Society of Civil Engineers and published in the Proceedings for October, 1908, p. 1101.

†Transactions, Am. Soc. C. E., Vol. XXXVIII, pp. 115-214.

*See article of Harvey D. Eaton, Esq., of Waterville, Journal, New England Water-Works Assoc., Vol. XIX, pp. 147-162, June, 1905. "The Maine Water Districts and Appraisers."

the fundamental gauge for the reasonableness of the rates, the basic principle outlined so beautifully in his opinion in the Brunswick case, as will be shown later in this paper. Thus, he says in the Waterville decision (97 Maine, 185):

"At the same time, the public have the right to demand that the rates shall be no higher than the services are worth to them, not in the aggregate, but as individuals." (Par. 4.)

"Summarized, these elemental principles are, the right of the company to derive a fair income based upon the fair value of the property at the time it is being used for the public, taking into account the cost of maintenance or depreciation, and current operating expenses, and the right of the public to have no more exacted than the services in themselves are worth." (Par. 5.)

Had Judge Savage but omitted the last seven words in his Paragraph 4 (the first just quoted), and thus made his gauge or standard the worth of the service to the public, or had he changed the last words in Paragraph 5 to read "than the services are worth to them, in the aggregate or as individuals, as he did in substance in his later opinion, all confusion would have been avoided.

However, if the Waterville opinion was weak in this respect, it laid down specific rules for the appraisers' (and counsels' and experts') guidance upon the following points—rules which have been of great service in these cases—and thus propounded the law in advance of the establishment of the essential facts in the case to be adjudicated, a very difficult, exacting and dangerous task:

The property of the company includes the real estate or other property, the plant or physical system, all franchises, rights and privileges, exercised or capable of being exercised. (97 Maine, Par. 1, 27.)

The real estate must be appraised at its fair market value not at forced sale but at worth to seller under prudent and beneficial sale. (Par. 1, 7.)

Actual construction cost (with proper allowance for depreciation) and reproduction cost are competent but not conclusive or controlling evidence. (Par. 8.)

Structure value should include going concern with a profitable business established, and with a present income assured and now being earned, if proved. (Par. 19.) Good will should not be considered so far as the water system is practically exclusive. (Par. 20.)

In fixing structure value, including the element of going concern, consider also the present efficiency of the system, quality of the water and service, fitness of the plant and of the sources of water supply to meet reasonable requirements in present or future, necessary time to construct *de novo*, and the time and cost needed after construction to develop such new system to the level of the present one in

respect to business and income, and the added net income and profits which would accrue during this period of construction and development.* (Par. 11, 21.)

Franchise value depends upon its net earning power, under reasonable rates. The value to be assessed is the value to the seller, not the buyer, but always subject to the fairness of the rates. (Par. 23.) So-called unlimited franchises are neither perpetual nor irrevocable (Par. 7), nevertheless the fact that the franchises are to be taken in no respect impairs their value. (Par. 26.) Past unfaithfulness, misbehavior or delinquencies of company involving perhaps liability to forfeiture of the franchises are not a consideration. (Par. 13, 14.) In considering prospective development and use of the franchise, the further investment necessary and effect upon income and rates are pertinent matters. (Par. 24.)

The basis of all calculation as to the reasonableness of the rates is the fair value of the property used by the public service corporation for the convenience of the public, and the company is entitled to charge reasonable rates for its service and no more. (Par. 3, 5, 2.) No more shall be exacted from the public than the services in themselves are worth, or are worth to the public as individuals. (Par. 4, 5.) The actual earnings of and rates charged by the company are admissible evidence, but their weight is dependent upon the reasonableness of the rates among other things. (Par. 10.) The early hazard and losses are also to be considered with reference to the past income, which might otherwise have been excessive. (Par. 6.) Even if excessive, no deduction is to be made for the rates collected in the past, but the fact is to be borne in mind in considering the present or future income. (Par. 15.)

"Capitalization of income, even at reasonable rates, cannot be adopted as a sufficient or satisfactory test of present value. But while not a test, present and probable future earnings at reasonable rates are properly to be considered in determining the present value of the system."

THE BRUNSWICK OPINION.

In 1905 the Brunswick and Topsham Water District took the works of the Maine Water Company, supplying the City of Brunswick (leaving to the company that portion of its plant supplying the City of Bath), and, as in the Waterville case, under legislative authority obtained from the Supreme Court of Maine, in advance of the trial of the case, an opinion covering the same general ground as the Waterville opinion—eminent domain, instruction to appraisers, franchise valuation, damages, evidence, and private and special laws.†

Fortunately, this duty again fell to Judge Savage, for it gave him the opportunity to

*The latter would seem to come rather under the head of franchise and future earnings than under structure value and going concern.

†Brunswick and Topsham Water District vs. Maine Water Company, Savage, J., 99 Maine, 371-389.

clear up the ambiguity of his earlier decision and to carry forward his admirable work—for these two masterly decisions bid fair to play a most important part in the future, not only in water-works valuation, but also in "fair-rates" cases involving public service corporations.

The legislature is not competent to prescribe rules for damage, but rules assented to by the inhabitants of the water district are made binding by their approval of the charter. (Maine, 99, p. 12.)

Actual construction cost bears upon reasonableness of rates and present value, but is not conclusive. If by rise of prices the present value is greater than the original cost, the owner is entitled to the appreciation; if less, he must suffer the loss. (Par. 4.)

Structure value must include consideration of the facts that the structure is in use, is a going concern, is lawfully in use, that is, that the structure is a going concern in use by virtue of a franchise. (Par. 2, 3.)

The reproduction cost is to be figured as of the date of taking at prices for materials and labor during a period long enough before that time for the construction and final completion of the works on the date of taking; and interest during the construction period is to be allowed upon the money invested as a part of the construction cost. (Par. 10.)

Reasonableness of the rates must be based upon the fair value of the property used by the company for the service of the public, including therein not only structure and going concern values, but also franchise value. (Par. 1.) The reasonableness of the rates relates to both the owner and the customer, but in case of conflict the rates must in any event be reasonable to the customer. (Par. 6.) The reasonableness of rates must be determined by the preponderance of evidence. (Par. 9.) The amount of money actually and wisely expended in producing the plant is a primary consideration. (Par. 5.) Profits which in the aggregate exceed a fair return on the property and franchise of the company do involve unreasonable rates. (Par. 8.)

Worth of the Service.—"A public service company cannot lawfully charge more than the services are reasonably worth to the public as individuals, even if charges so limited would fail to produce a fair return to the owner upon his property or investment." (Par. 7.)

"The worth of a water service in such connection is the worth to the customers as individuals, but as individuals making up a community of water takers." (Par. 14.)

"In estimating the value of a public service to the public or the customers, one of the elements necessary to be considered is the expense at which the public or customers, as a community, might serve themselves, were they free to do so, and were it not for the practically exclusive fran-

chises of the supplying company. Water is to be regarded as a product, and the cost at which it can be produced or distributed is an important, though not the only element of its worth." (Par. 13.)

Communities are entitled to the benefit of natural advantages, and the company is not entitled to charge enhanced rates based upon the cost of using the more expensive source. (Par. 15.)

Damages for severance are to be allowed. (Par. 11, 16.)

Eminent domain.—The award is to be made under the principles of eminent domain and upon such principles of eminent domain as were agreed to by the voting constituents of the water district by approving the charter.

GENERAL CONSIDERATIONS AFFECTING WATER-WORKS VALUATION AND FAIR RATES.

The following outline indicates in a general way the more important considerations bearing upon water-works valuation and rating and the scope of the inquiry which the expert will be likely to wish to make in order to form his judgment as to the value of any particular works or the fairness of the rates charged by them:

A.—Data Relating to Community.—

- 1.—Character of population, and industries and buildings.
- 2.—Population: Past, present, and probable future, United States, State, and Local Census.
- 3.—Assessed valuation: Past and present.

B.—History of Plant and Dates of Construction and Further Development.

C.—Legal Rights.—

- 1.—Form of incorporation: Charter.
- 2.—Franchise: Exclusive or not, perpetual or limited, terms of purchase or extension.
- 3.—Contracts for public and private water service: Terms, time, and prices.
- 4.—Tax exemption or otherwise.
- 5.—General laws affecting company: Local ordinances or orders.

D.—Physical Plant.—

- 1.—Source of supply: Character, artesian, ground, surface.
- 2.—Population on water-sheds, and sanitary conditions.
- 3.—Quality.
- 4.—Quantity, available drainage area; storage and pondage, variation in yield.
- 5.—Adequacy for present and probable future needs.
- 6.—Local rainfall and flow statistics.
- 7.—Number of taps, services, and consumers; number of meters.
- 8.—Water consumption and uses: Gallons, average per day, total, per capita, per service, or tap.
- 9.—Variation in and character of consumption.
- 10.—Reservoir system: Character, amount, location or distribution.
- 11.—Pipe distribution system: Character, kind, and extent.

- 12.—Efficiency: Age, deterioration, probable life, effects of electrolysis, etc.
- 13.—Available domestic supply, quantity and pressure.
- 14.—Available fire supply, number and character of streams.
- 15.—Adequacy of service as compared with present and probable future needs.
- 16.—Necessary reinforcement.
- 17.—Possible competitive sources of supply, with data for comparative estimates of cost.
- 18.—Pumping station data.
- 19.—Purification data, sedimentation, filtration, softening, etc.
- 20.—Plans: General and detail; elevations, etc.

E.—Local Prices of Labor and Building Materials; Hours of Employment; Ordinances in Regard to Labor, etc.

F.—Rates.—

- 1.—Schedule of public, commercial, and domestic rates, past and present.
- 2.—Rates elsewhere in vicinity (probably not admissible as evidence, but of service to experts).

G.—Operating Statistics.—(Annual for period of years, or during life of plant, if possible.)

- 1.—Gross income.
 - a.—Classification of gross income: Public hydrants and other uses; domestic and manufacturing; metered and fixture service; license or permit for tapping; profit on services; house plumbing, etc.
- 2.—Operating expenses.
 - a.—Administration salaries and wages; legal, engineering, general, and miscellaneous expense.
 - b.—Buildings and real estate: Rental, care and repairs.
 - c.—Pumping: Labor, fuel, oil and waste, sundries, repairs.
 - d.—Filtration: Labor, chemical coagulation supplies, sundries, repairs.
 - e.—Street mains and service pipe work: Labor, supplies, miscellaneous repairs.
 - f.—Meters: Labor, supplies, miscellaneous repairs.
 - g.—Insurance and taxes.
- 3.—Net income = gross income less operating expenses.
- 4.—Maintenance = depreciation and renewals.
- 5.—Fixed charges: Interest on bonds and floating loans.
- 6.—Sinking fund requirements.
- 7.—Dividends on stock and surplus.
- 8.—Unit figures: Gross and net income, per million gallons daily, per tap, per capita, per mile of pipe, to be derived from the above.

H.—Sinking Fund, Surplus, and Interest and Dividends Paid in Past, and Resulting Average Earnings upon Original Cost or Investment.

- I.—Real Estate and Water Rights, etc.—
 - 1.—Cost of.

- 2.—Market value of.
- 3.—Assessed value of.

J.—Structure Value.—

- 1.—Original cost of original plant and subsequent extensions and betterments:
 - a.—Date and amount of.
 - b.—Character of prices, as compared with normal prices of that time.
 - c.—Reasonableness of outlays and provisions for the future.
 - d.—Date and amount of extensions and betterments.
- 2.—Reproduction cost as of date of taking, buying materials sufficiently in advance to have plant ready for operation on date of taking.
- 3.—Depreciation: Annual and total to date.
- 4.—Cost of betterments or necessary improvement of service, completed as of date of taking.
 - a.—Anticipated increase in earnings from these betterments.
 - b.—Anticipated increase or decrease in operating expenses from these betterments.
 - c.—Depreciation and fixed charges upon these betterments.
 - d.—Difference, or net increment or charge.
- 5.—Competitive sources. Cost of and charges that would result.

K.—Lawful Rates and Value.—

- 1.—Reasonable ratio of profit to the owner or promoter in excess of the actual reasonable cost of the property. This must be limited by the consideration of the profit or excess over cost which the public would probably have been willing to allow the corporation at the time of its incorporation, as compensation for relieving the city of the necessity of undertaking the work itself, as it might have done at cost, but which it then elected to have done for it at cost plus profit. (The reasonable amount of this profit will be discussed hereafter.)
- 2.—Rate of interest to be allowed upon investment, or property, commensurate with property of equal security, safety, and risk.
- 3.—Annual allowance for depreciation.
- 4.—Market value of real estate and supplies on hand.
- 5.—Worth of service to consumer or lawful gross annual income for given investment. Reasonable annual operating cost including repairs; plus annual depreciation; plus interest upon the sum of the reproduction cost* and profit increment less total depreciation to date (if the latter has been previously earned). This sum measures the lawful annual

*The reasonableness of using a fair average reproduction cost instead of the reproduction cost upon the date of taking, or the original cost, is discussed later.

gross income, if the works are capable of earning it.

6.—Comparison of lawful with actual annual gross income.

7.—Value determined by reproduction cost plus profit increment less total depreciation to date (if previously earned), plus market value of real estate and supplies on hand, provided the actual annual gross income equals or exceeds the lawful annual gross income.

8.—If actual annual gross income is less than the above determined lawful annual gross income, value is determined by capitalizing, at the assumed fair rate of interest, the actual net income derived by deducting from the gross annual income the operating expenses and annual depreciation allowance; increasing this sum by the market value of the real estate, and decreasing it by the depreciation to date (if the latter has been earned previously in the rates).

9.—Calculate equivalent annual rate of return to the owner of this lawful income, upon the actual cost and upon the fair average reproduction cost of the works.

10.—Corrections to be applied on account of necessary betterment or improvement in efficiency of the plant, with due allowance for any possible increase as well as decrease in income, operating expenses, maintenance and fixed charges.

11.—Resulting value to owner, subjects to limitation of reasonable rates and reasonably efficient service (including therein the necessary improvements or betterments).

L.—Results to City of Award of Assumed Value.—

1.—Assumed value or award.

2.—Annual combined cost of operation, depreciation and (or) sinking fund, interest upon investment.

3.—Present annual income.

4.—Net result upon present conditions.

5.—Similar figures with allowance for increase or decrease in earnings, operating expenses, depreciation and fixed charges, due to betterments or necessary improvement of efficiency or standard of service. It may be of interest, though not logically correct, to include in the total investment the actual cost to the city of acquiring the property, that is, the cost of court, legal, expert, and witness fees and expenses.

M.—Going Concern Element of Value.—

Note that this element of value is included in the above valuation, and is of significance or importance chiefly in cases involving valuation of plants taken after expiration of their franchises.

Company's Plant.—First Year.—Net income at date of taking.

Newly Built Plant.—Probable gross income for year, less operating expenses, plus saving in state and county taxes.*

Loss in first year by operation of new plant by city.

Second year.—Net annual income as of date of taking.

Probable gross income for year, less operating expenses, plus saving in state and county taxes.*

Loss in second year by operation of new plant by city.

Similarly for third, fourth, etc., years to time at which the city may be assumed to have developed the business to a point equal to the net annual income at date of taking.

The total sum of the present worths of these annual losses may be considered to be the "going concern value."

N.—The Subjoined Form for Collecting and Preserving Financial Data Relating to Water-Works.—This form (page 1113), used by the writer for some years, may also be of service.

SOME COMMENTS UPON THE ABOVE CONSIDERATIONS AFFECTING WATER-WORKS VALUATION AND RATES. LEGAL RIGHTS.

Inasmuch as the majority of Maine water-works franchises may be classed under the popular head of "perpetual franchises," and as the illustrations given in this paper come under this class, the discussion has been limited to franchises of this class. The general principle of the worth of the service to the consumer is equally applicable and valuable, however, in its bearing upon fair rates, to limited term franchises.

ORIGINAL COST.

The Brunswick opinion gives new life and significance to the original cost, which, heretofore, has received comparatively little consideration, if any, in valuation proceedings in the United States, other than in its remote bearing upon the total depreciation of the plant to date. While it is recognized that in many, perhaps in most, cases it may not be possible to determine the actual first cost, where available, it may have a very important bearing upon the case, particularly if the cost was a normal and reasonable one at the date of construction.

The reasonable annual return to be allowed the builder of the works upon their original cost (referred to later) is largely a matter of judgment, and will be influenced by many considerations. Roughly speaking, it may vary from 7 to 10 per cent or even more, the smaller rate reflecting the larger works, the better topographical

*Interest charges not included as they are the same for both plants, if we assume both plants ready for operation as of date of taking. Annual depreciation assumed to be the same for both plants, hence ignored. The town taxes are not assumed to be saved by the town, as it must make good, by general taxation, any loss from reduction of taxes upon company's plant or abolition thereof in case of taking of the plant by the city.

or physical conditions, the more promising field, the greater ease and lesser expense of making provision for the future, etc., the greater freedom from danger of competition, the smaller hazard, and the more stable character of the community; the larger rate reflecting the reverse.

REPRODUCTION COST.

The cost has always been recognized as pertinent and important, though not controlling, in valuation cases.

It has had its greatest influence in the case of works taken after expiration of franchise, when the reproduction cost, depreciation, and going concern value have been very important, if not controlling, elements of value.

Even so, under the Brunswick ruling, reproduction cost has a new force in its bearing upon the cost to the public of supplying itself—the worth of the service to the consumer—and hence upon the reasonableness of the rates. Upon the latter subject more will be said under the caption of the "Measure of Fair Rates."

Reproduction Cost.—Court Rulings upon Prices to be Assumed.—The method of figuring the reproduction cost of the plant, prescribed by the courts in different states, varies considerably, so that the results obtained under one ruling may be quite different from those obtained under another, particularly in large plants involving a construction period of several years.

The Maine opinions clearly prescribe the assumption of prices prevailing at a time in advance of or prior to the date of taking, corresponding to the probable period of construction, upon the theory that the plant is to be built and delivered complete upon the actual date of taking.

In the Kansas City case,* and in a number of other cases, on the other hand, prices prevailing upon the date of the taking were taken, upon the theory that the valuation was made as of the date of taking and hence that the prices of that date should be assumed.

Thus, in the Portland (Maine) valuation suit, the several engineers assumed periods of construction from 2 to 3 years, and made allowance for the interest charges upon construction within this period, with a resulting agreed reproduction cost, including hydrants (owned by the city) and services (laid at the expense of the water takers), of \$2,853,696, cast-iron pipe being figured at approximately \$29 per net ton—all under the Maine ruling before referred to. Had the Kansas City ruling been used, the price of cast-iron pipe would have been approximately \$25, with a reduction in the reproduction cost of about \$80,000. While the deduction for depreciation would have offset this decrease in some measure, the net results would still have been much less.

This illustration leads to the natural suggestion that in equity, at least, a reproduction cost based upon normal or average prices for a period of years prior to date

of taking would be a fairer criterion than one based upon the monthly or daily fluctuations of the material and labor market.*

Reproduction Cost.—Identical Structure vs. Structure of Equal Efficiency.—The courts are also divided upon the subject as to whether, in calculating the reproduction cost of a structure, the actual lines of the structure, or, in other words, the identical structure under consideration should be adhered to, or, on the other hand, whether the cost may be measured by that of a structure of equal efficiency. The Maine courts have taken the former view, the Federal Court in the Kansas City suit, the latter. In a comparatively new or young plant the difference may be insignificant, in an old plant it is likely to be large. Something may be said in favor of both methods, though the latter, if reasonably applied, would appear to have greater merit from a business standpoint. The owner may claim that the plant, though obsolete or old-fashioned and not what he would build were he building anew on the date of taking, is still serving the public adequately; whereas the buyer of the plant would not be likely to value a multiplicity of parts, as, for instance, three or four supply mains, built in sequence and costing far more than one unit, at a materially higher figure than one equivalent unit, except perhaps in so far as duplication may give an added factor of safety in operation. Moreover, if, through the agency of rates, the owner of the property has collected from the public a depreciation allowance sufficient to make good this loss in efficiency, it is but just to the public and not unfair to him to consider reproduction cost from the point of view of a structure of equal efficiency rather than of identical parts. Whatever the views of the expert, however, the laws of the community or the counsels' interpretation of them will hold.

(To be continued.)

The premature explosion of a 25-ton dynamite blast at Bas Obispo on the Panama Canal on Dec. 12 caused the death of at least 13 men and the injury of many others. The charge consisted of 51 holes, spread over a large area, and according to the press dispatches, the last hole was being charged when it exploded, the concussion setting off the rest of the charges.

Bids were opened Dec. 1 by the Board of Water Supply, of New York City, for contracts Nos. 36 and 37, for constructing the north half of the Walkill pressure tunnel. Booth & Flinn, Pittsburg, Pa., at \$3,365,000, was low bidder.

The excavation on the Isthmian Canal during November amounted to 2,920,494 cu. yds.

*National Water Works Company vs. Kansas City, 62 Federal Reporter, 853-869.

†See also pages 1135, 1136, 1139 et seq.

Method of Making Rubber Pipe Joints With Some Costs.*

BY ROBERT SPURR WESTON.†

During the past winter in Europe the writer noticed that much water pipe was being jointed with pure rubber rings in place of the customary lead and yard. It is thought that this simple process might be of interest and use to the members of this association. The process was very simple. The rubber ring was slipped over the spigot end of the pipe, the spigot of this pipe was then forced into the bell of the next pipe by means of a long lever, compressing the rubber between the iron surfaces and making a very tight joint. Clay was then forced into the remaining space and the job was done.

The following information was obtained regarding this method of jointing. To begin with, the "Normal" pipe of the Verein deutscher Ingenieure has the form shown in Fig. 1.

The thickness of the shell of this normal pipe is determined by the formula

$$d = 6.0 + 0.001 \times D \times A = \text{thickness in millimeters.}$$

where

D = inside diameter in millimeters.

A = testing pressure of 20 atmospheres.

The German pipe is made in more sizes than is customary in this country. A few of the dimensions of the "Normal" pipe corresponding to the standard New England Water Works Association pipe diameters, and expressed in equivalent United States units of measure, are given in Table I:

TABLE I.—SIZES OF GERMAN "NORMAL" PIPE.

INSIDE DIAMETER, Ins.	INSIDE DIAMETER, Millimeters.	Outside Diameter, Ins.	Laid Length, Ft.	Diameter of Sockets, Ins.	Depth of Sockets, Ins.	Width of Joint Space, Ins.
4	100	4.65	9.9	5.24	3.46	0.30
6	150	6.69	9.9	7.28	3.70	0.30
8	200	8.75	9.9	9.37	3.94	0.32
10	250	10.78	11.1	11.44	4.05	0.33
12	300	12.82	13.1	13.10	4.13	0.33
14	350	14.88	13.1	15.53	4.21	0.33
16	400	16.89	13.1	17.64	4.33	0.37
18	450	18.96	13.1	19.63	4.41	0.37
20	500	20.93	13.1	21.73	4.53	0.39
24	600	24.97	13.1	25.78	4.72	0.41
30	750	31.10	13.1	31.98	5.00	0.43
36	900	37.20	13.1	38.18	5.31	0.49
48	1,200	49.40	13.1	50.52	5.90	0.51

It will be noted that the "Normal" pipe differs in many particulars from the New England Water Works Association standard pipe, e. g.:

First. There is neither lead on the end

of this spigot nor retention spaces for the lead in the bell.

Second. The socket is deeper, and there is a shoulder in the bell which serves the purposes of the lead on the New England Water Works Association standard pipe.

Third. The increase in dimensions of socket vary more uniformly with the increase in diameter of the pipe.

Fourth. Should the shell of the pipe be thickened the outside diameter remains constant.

In thickness of shell, the German pipe lies between classes A and B of the New England Water Works Association standards.

The German pipe is recommended for

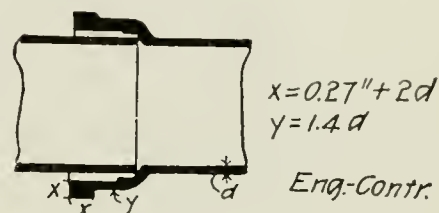


Fig. 1.

general use with pressures varying from 60 to 105 lbs. per sq. in.

Pipe for use with rubber rings should not have the retention space cast in the bell, and the spigot may have a groove 0.2 in. deep to prevent the ring slipping during process of jointing. This groove is sometimes omitted. The pressure which the joint will withstand depends upon the degree of compression, and consequently the holding friction of the rubber ring. The groove permits a thicker ring to be used than is possible without it.

The following sketch (Fig. 2) shows how "Standard" pipe may be adapted for use with rubber rings, and the degree of compression to which the ring would be subjected in practice. The thickness of

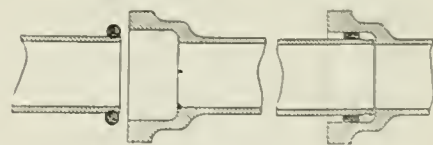


Fig. 2.

the ring before compression should be twice the width of the joint. The inside diameter of the rings should be somewhat less than the outside diameter of the pipe, that they may be held in place by their own elasticity during the processes of jointing.

The sizes of the rings for pipes of classes A, B, and C would be as shown by Table II.

The rubber rings used should be of the best pure gum, preferably the variety known as Para gum. They cost from \$2.50 to \$3 a pound at present prices, and are usually made of pure gum rods, butt-jointed and vulcanized. Their cross section is circular. Rings of hemp coated

*A paper read before the New England Water Works Association.

†Sanitary expert, Boston, Mass.

with rubber have been tried, but are not to be recommended because of their low elasticity, upon which the tightness of the joint depends.

The comparative costs per joint of lead and rubber joints may be estimated as follows (Table III.), assuming lead to cost 5 cts. and rubber \$3 a pound, and using New England Water Works Association

TABLE II.

Diam. of Pipe, Ins.	Inside Diam. of Ring, Ins.	Thickness of Ring, Ins.	Weight of Ring, lbs.
4	4.50	0.80	0.136
6	6.50	0.80	0.195
8	8.50	0.80	0.247
10	10.25	0.80	0.294
12	12.25	0.80	0.348
14	11.25	0.80	0.401
16	16.25	1.00	1.437
18	18.00	1.00	1.582
20	20.00	1.00	1.747
24	24.00	1.00	2.081
30	30.00	1.00	2.45
36	36.00	1.00	3.08

standard pipe without the retention space:

It will be noted that up to and including 14-in. pipe the rubber joint is a little cheaper, even without allowing for the cost of bell-holes not needed for jointing with rubber rings. There is no reason why the width of joint for pipe 16 ins. in diameter and above could not be reduced to 0.45 in., or even 0.40 in., when the cost

TABLE III.

COMPARATIVE COSTS OF LEAD AND RUBBER PIPE JOINTS.

Diam. of Pipe, In.	Thickness of Joint, In.	Estimated Cost of Lead, Yarn, and Calking.	Cost of Rubber Ring.	Cost of Laying Lead.	TOTAL COST PER JOINT.	Rubber.
4	0.10	\$0.54	\$0.48	\$0.09	\$0.63	\$0.57
6	0.10	0.86	0.58	0.12	0.98	0.70
8	0.40	0.97	0.74	0.15	1.12	0.89
10	0.40	1.21	0.88	0.20	1.41	1.08
12	0.40	1.48	1.05	0.24	1.72	1.29
14	0.40	1.78	1.20	0.30	2.08	1.50
16	0.50	2.08	4.31	0.36	2.44	4.67
18	0.50	2.39	4.75	0.42	2.81	5.17
20	0.50	2.68	5.24	0.48	3.16	5.72
24	0.50	3.60	6.25	0.60	4.20	6.85
30	0.50	5.30	7.34	0.90	6.20	8.21
36	0.50	6.51	9.24	1.17	7.68	10.41

of rubber joints would be less than that of lead joints, as shown in Table IV.:

The advantages and disadvantages of the rubber joint may be stated as follows:

One of its chief advantages is that it is extremely flexible. The rubber ring is midway in the bell and therefore at the axis of movement. Therefore no serious unequal compression of the ring can re-

sult if the pipe be thrown out of line. The joint is almost perfectly tight and needs no calking; it may, therefore, take the place of flanged pipe for suction mains connecting tube wells. In such cases the position of the branches may be adapted to suit the wells. This is often a great convenience because it is impracticable in all cases to sink wells in exact predetermined positions. Pipe with rubber joints is easier to lay on account of these absence of bell-holes and the simplicity of the jointing tools. There is less breakage of pipe due to settlement of earth. It resists electrolysis most efficiently. The rubber joint, on the other hand, has not been used for high pressures. How much pressure it will withstand could not be ascertained. It is in use in systems which carry 50 lbs. pressure, and probably could be used for pressures considerably higher. The joints appear to be durable. If exposed to air, rubber absorbs oxygen, loses its elasticity, and becomes hard and useless. Compressed in a pipe joint, however, it is preserved. A ring removed after 18 years of service was apparently as good as new. It would be more durable in contact with ground water than with surface water.

Many German and European supplies

TABLE IV.

COMPARATIVE COSTS OF LEAD AND RUBBER PIPE JOINTS FOR PIPE 16 INS. AND OVER IN DIAMETER, HAVING A JOINT SPACE 0.40 INS. WIDE.

Diameter of Pipe, Ins.	Cost of Joint.	
	Lead.	Rubber.
16	\$2.44	\$1.89
18	2.81	2.11
20	3.16	2.31
24	4.20	2.82
30	6.20	3.56
36	7.68	4.13

are from wells driven in gathering grounds located above the level of the city. In several instances the water is siphoned from the wells to the distributing reservoir by means of rubber-jointed pipe. The proposed new water supply of Prague contemplates such a line from the mountains several miles distant from the city.

This paper is written with the hope that some members of this association may try these joints and determine their worth under the conditions of American water-works practice. While not at all new, they have not been tried in this country to any great extent. The writer wishes to thank Dr. A. Thiem, C. E., and Mr. A. Lang, C. E., of Leipsic, for information regarding the use of this joint.

Much interest is being manifested in the cement show of the Northwestern Cement Products Association, to be held March 2, 3 and 4 at Minneapolis, Minn. Four loving cups have already been donated and will be awarded to exhibitors.

The Field for Office Engineers.

BY DAVID R. COOPER.*

The organization of large modern engineering forces opens a comparatively new field for engineers. In a general sense it may be considered as the field of another specialist but in the strictest sense it is pre-eminently the field of the generalist. It is the field of the specialist in the sense that comparatively few engineers are qualified to enter the field, owing principally to the generality of the qualifications required, but these same conditions limit the number of available engineers for such positions to those who have had the broadest kind of experience, thus making it peculiarly the field for the engineer with general education, training and experience.

The need for office engineers has not been felt until the last few years, in which most of our large engineering forces have sprung into existence. Previous to this time engineers have had to do more or less of the work of the modern office engineer, but in such instances the work has been considered and executed simply as incidental to the more important duties of the engineer, and it was not considered necessary to have a special man, who should be an engineer, to do this work. But with the organization of such large modern engineering departments as those of the Board of Water Supply of New York City, the New York Central R. R., the Pennsylvania R. R., and many other large engineering forces of the country, the heads of various departments realized that they were spending a large part of their time attending to matters that took much time from their regular work and the need for office engineers became apparent. It was evidently necessary to the economical execution of the work of these large engineering departments to have competent engineers who should devote all of their time to the administration of office details, and, as it were, co-ordinate the business and technical ends of the organization.

No engineer could devote his best efforts to the solution of intricate engineering problems in his office and at the same time carry on correspondence with, receive reports from, and issue instructions to a large field force, with any marked degree of efficiency in his particular line of work. The connecting link in the strong chain of perfect organization is the office engineer, who comes between the office and field men, between the technical branch and the business branch of the engineering department itself, and between the engineering department as a whole on the one hand and the executive or administrative department or the public on the other hand. Evidently the broader the experience a man has the better he is qualified for such a position, and hence the difficulty that engi-

*Assistant Engineer, State Water Supply Commission, Albany, N. Y.

neering departments experience in getting men for such positions.

As to the qualifications for a good office engineer, they are many and varied, depending somewhat of course upon the scope of work being done by the department in which he is employed. In the first place he should be a good engineer, the most important attribute of which is good practical "common horse sense" and judgment, added to the necessary mathematical framework. Most experienced engineers have these qualifications or they would not have survived in the profession long enough to be considered experienced. Hence the choice of an office engineer must be based on other considerations. In general, the office engineer should be as capable of taking interest in and understanding the work of the man who is taking boring samples for a dam site at some isolated place in the mountains, as he is of understanding the importance of computing the stresses in a bridge truss. In other words he should be broad minded and a man of unbiased judgement to whom every branch and detail of engineering work is of some interest in order that he may appreciate the relative importance of all parts of the work of the engineering department to such a degree as to deal with each part of the work with the proper degree of consideration, and with due respect for its relative importance.

Owing to the nature of his duties, a good office engineer must be endowed with a certain amount of executive ability, that he may effectively direct such subordinates as he may require to assist him in his work. In addition to these most important attributes he must be neat and systematic, for the sake of neatness and system if for no better reason. He should also be original to a certain degree, since the position he fills is one, the limit of whose duties and obligations are not fixed as yet by a universal code of rules, which fact may result at any time in his being called upon to perform duties with which he is unfamiliar. Originality would often enable him to accomplish the desired end. Then too, he must be careful even to the degree of being painstaking, for in his dealings with more than one department it is quite probable that he will be subject to a great deal of blame and criticism. He is of course, responsible for the proper negotiation of business with other departments or outside concerns, hence has numerous opportunities to make errors such as the misinterpretation of the subject matter and a resultant misrepresentation of the facts to the second party to the negotiation. For this same reason, perhaps, one of the most important qualifications of a successful office engineer is that he should be of a cheerful disposition and especially fond of the varied duties he has to perform. The position is properly classed as a "thankless job" in the sense that the portion of "censure and criticism is very likely to exceed the commendations and appreciation. On

the other hand there is no better opportunity in an engineering force for a man to make his qualifications known. The position has some important advantages on this account as will be referred to later.

With reference to the education of an office engineer, it is, of course, desirable that he be a technical graduate although this qualification is less essential in this position than in any other responsible position in an engineering organization. A good course in mathematics is essential, but of two men who are equally qualified so far as mathematics is concerned, the one being a technical graduate and the other not a graduate, but a man fully qualified otherwise to fill the position, the duties of the position are so varied that the non-graduate may frequently be better qualified for the position than the graduate, considering such qualifications as executive ability, systematic methods, etc. Everything else being equal the man who has had some education along commercial lines such as banking, bookkeeping, or accounting, would have the advantage owing to the fact that some knowledge of such things would assist materially in the execution of his duties.

Of quite as much importance as his personal and educational qualifications are the qualifications gained by the practical experience of the engineer who would fill this position. In general it may be said that the broader his experience the better. However, the required scope of his experience depends mostly upon the class and extent of engineering work being done by the department in which he is employed. Every other consideration being equal, a firm of hydro-electric engineers would prefer a man with experience in water power; a railroad would prefer a railroad engineer. But as previously stated, the need for office engineers is felt mostly in large engineering departments, where, however special may be the lines of interest of the department, there is necessarily a certain amount of work to be done that requires for its execution at least a superficial knowledge of most every branch of engineering work. The larger the organization the more general will be the scope of the work and the more different branches of engineering will be involved. Consequently it would seem that in most cases it is imperative that the office engineer should have had some practical experience in several different lines of engineering work.

Considering also the scope of his duties, it seems that his general experience and training in lines other than engineering are well worthy of consideration. For example, part of his duties being in connection with the office records of the engineering department, any experience that he may have had in connection with indexing or filing systems should be of practical value in his work. A knowledge of bookkeeping would also be of service. So also would the knowledge of any other

branch of commercial methods be useful, the scope of his duties being so varied that most any business experience he may have had would be of value in his work.

As stated before in a general way, the duties of the office engineer are necessarily miscellaneous. To him falls the duty of administering all office details, many of them matters that it would be difficult to say were engineering or not engineering. He has supervision of all the accounts and records of the engineering department. In a new organization it becomes his duty to devise filing and indexing systems for all office records, such as drawings, computations, field notes, correspondence, etc. In an office already established it is his duty to supervise the operation of the filing and indexing systems. If the department issues bulletins, catalogues, or reports, or any other publication, the office engineer is required to edit the manuscript.

The reports from field parties are returned to the office engineer, who makes the proper disposition of such things, usually after consulting with the head of the department or part of the department most interested. Oftentimes some representatives of the department may be operating in the field, and their entire direction is delegated to the office engineer. Any drawings in the nature of office records, such as progress maps of surveys, or progress profiles of earthwork, are made under the supervision of the office engineer. If the department is investigating some engineering problem and wishes to know what others have done along the same lines, the office engineer makes research for such information as is available, abstract reports, and himself submits a report to the head of the engineering department. In short, the office engineer has duties so varied even among different engineering organizations that it is difficult to say just what the limit of his duties should be. Be that as it may, the need for such a man in an engineering organization is being felt more strongly every year, and it appears that the demand is on the increase.

The question as to what will be the future of the office engineer is perhaps difficult to answer at this time, but it seems safe to predict that it is only a question of a few years until he will be an indispensable part of the organization of every engineering force. Perhaps young men will be entering our colleges with the intention of becoming office engineers. Their course in college will be varied somewhat from the existing courses. They will study more different branches of engineering, but will study them less in detail. Skill in English composition and the ability to express their ideas in clear, forcible English will be an essential part of their training. Perhaps short courses in commercial branches will be included.

The prospects of the office engineer for advancement are very promising. The position is the natural stepping stone from

an engineering to an executive or administrative position. As such, it is through this position that the engineer may expect most naturally to advance to such a position as that of general manager of a railroad, for instance. It is a well-known fact that such positions requiring men with executive ability and business experience are much more remunerative on the basis of comparative mental ability than engineering positions. It seems probable therefore that engineers will use this position as a means of advancement to a position for which they would be unable to demonstrate their fitness were it not for the position of office engineer.

The Method and Cost of Removing a Suspension Bridge.

A highway bridge was built in 1875 for the city of Minneapolis, across the Mississippi. It was torn down in 1890 by contract. The span was 670 ft., and it carried a 20 ft. roadway flanked on each side by a 6 ft. sidewalk. The towers were of masonry. Each of the two main cables was 10 ins. diameter, containing 3,150 No. 9 wires. Each of the two sidewalk cables contained 150 No. 9 wires. The floor system was wood. There were 4 lines of stiffening Howe trusses, 6 ft. deep. The original cost of this bridge was as follows:

Towers	\$41,000
Anchorage	20,500
Wires	30,000
Erection	27,000
Drawing for patterns, etc.....	1,250
Engineer	7,550

Total	\$127,500
Approaches	71,500

Total	\$199,000
-------------	-----------

The No. 9, hard drawn charcoal wire cost 5½ cts. per lb. f. o. b. Trenton, N. J.

The following were the quantities involved in removing this bridge:

1,928 ft. 10-in. cable.....	330,000 lbs.
1,928 ft. 4-in. cable.....	61,000 lbs.
Suspenders and stays.....	34,000 lbs.
Iron rods (laterals, suspenders, etc.), ties and bolts.....	31,000 lbs.
Cast iron washers, splice plates, angle blocks, etc.....	50,000 lbs.

Total metal	506,000 lbs.
Lumber	180,000 ft. B. M.
Limestone masonry	1,432 cu. yds.

The towers and anchor piers were removed to a depth of 2 ft. below the street level.

In taking down the cable it was found best to cut a bunch of wires at both sides, and then loosen the bunch as far as possible from the rest by inserting iron bars and working these bars along the cable. Then each wire was pulled out by a winch driven by an engine. The winch was pro-

vided with a reel large enough to hold a wire 975 ft. long. The crew engaged in taking down the cables was as follows:

1 laborers at \$1.75	\$7.00
1 foreman	3.00
1 team	3.50
1 engine and engineman.....	5.00
Coal, oil, etc.	2.00

	\$20.50
10 per cent on tools, etc.....	2.00

Total	\$22.50
-------------	---------

It cost 31 cts. per wire to remove a sidewalk cable. It cost 22 cts. per wire to remove the first main cable, and 18½ cts. per wire for the second cable. Since each wire weighed 50 lbs., the cost was 0.4 ct. per lb. when it cost an average of 20 cts. per wire.

The actual cost to the contractor for taking down the bridge was as follows:

Taking down and storing 1,300 cu. yds. masonry	\$1,400
Taking down superstructure	1,498

Total	\$2,898
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Since there were 506,000 lbs. of iron in the superstructure, beside 180 M. of lumber, it is seen that it cost less than 0.3 ct. per lb. to take down the superstructure.

It cost \$1.10 per cu. yd. to take down and store the limestone masonry.

Mr. F. W. Cappelen is authority for the foregoing data.

Persanals.

Edward F. C. Young, President of the Joseph Dixon Crucible Co., died Dec. 6 at his home in Jersey City, N. J., from cancer.

Carroll L. Treat, of the firm of Wood, Treat & Davis, Railroad Contractors, died Dec. 5, at the Franklin Hospital, Franklin, Pa.

McDaniel & Trimmer have opened offices in Vermillion, S. Dak., where they will engage in the practice of civil engineering and architecture.

Mr. E. G. Hopson, Supervising Engineer of the Pacific Division of the U. S. Reclamation Service, sailed for Europe recently, and expects to be abroad during December and January.

Mr. George T. Prince, formerly Chief Engineer of the Denver Union Water Co., of Denver, Colo., has opened offices in the Symes Bldg., Denver, where he will engage in practice as a consulting hydraulic engineer.

Mr. William Kent, formerly Dean of the College of Applied Science at Syracuse, N. Y., will on Jan. 1 become General Manager and Superintendent of the plant of the Sandusky Foundry & Machinery Co., Sandusky, O.

Mr. Samuel W. Stratton, Director Bureau of Standards, U. S. Department of Commerce and Labor, delivered the founder's day address at the 12th anniversary, Dec. 1, of the Thomas S. Clarkson Memorial School of Technology.

Mr. James R. Potter and Mr. Russell B. Smith have opened offices at 4 Coleman Bldg., Philadelphia, Pa., under the firm name of Potter, Smith & Co., and will engage in a civil engineering and contracting business.

D. D. Waldo, Resident Engineer in charge of State highways in Western New York, with office at Albion, N. Y., died Nov. 30 after a short illness. Mr. Waldo had been connected with the New York State Engineering Department for the last 25 years.

Mr. Richard I. D. Ashbridge, formerly a member of the engineering force of Philadelphia, Pa., has been selected as Chief Engineer for the proposed tunnels to be constructed under the Delaware River between Camden, N. J., and Philadelphia.

Mr. John J. Russell, since April 1 in charge of the Aurora (Ill.) division of the Chicago, Burlington & Quincy R. R., has resigned to accept a position in charge of construction work for the Spokane, Portland & Seattle R. R., with headquarters at Portland, Ore.

Mr. Ellis Soper has resigned his position as Vice President of the Hunt Engineering Co., Iola, Kan., and Superintendent of the Dixie Portland Cement Co., South Pittsburg, Tenn., to become President of the Soper Co., with headquarters at 1110-11 Ford Bldg., Detroit, Mich. The Soper Co. has been organized for the purpose of dealing in all standard cement machinery and doing general cement engineering work. The officers are: Ellis Soper, Detroit, Mich., President; H. G. Hamilton, Youngstown, O., Vice President; W. J. Thompson, Youngstown, O., Secretary and Treasurer.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 1013. **Fire Proof House.**—Evlock Eng. Co., 90 West St., New York.

A bulletin telling of the construction of a fire proof house built of Hinton insulated hollow burnt tiles. The walls, floors and roof can be made of this construction.

No. 1014. **Material Handling Devices.**—Bergen Point Iron Works, 149 Broadway, New York.

A well printed 50-page catalog devoted to a description of the unique products of this company. Dump buckets and tubs, concrete mixer feeding machinery, small dump cars, and a low dump wagon. Coal handling machinery, gate valves for bins, and guillotine gates, larry buggies, stoking devices and other products.

No. 1015. **Portable Air Compressors.**—Allis-Chalmers Co., Milwaukee, Wis.

This bulletin illustrates and describes briefly the electric motor driven air compressor plants made by the company named. The plants consist of a very compact arrangement of motor, compressor and air receiver mounted on trucks and capable for the smaller sizes of being hauled from place to place by hand. Contractors will be interested in these plants.

No. 1016. **A Practical Guide for Transformer Testing.**—Fort Wayne Electric Works, Fort Wayne, Ind.

This 47-page pamphlet introduces its subject as follows: "The static transformer in mechanical make-up, while one of the simplest of electrical devices, is theoretically very complicated. In nearly all publications issued for the benefit of central station operators, relative to transformers, the matter is presented in a too complicated form to be made practical use of and appreciated by the practical central station operator; and it is the object of this publication to present, in a simple manner, methods of testing which will assist Central Station Engineers in testing out transformers of any make, so that they can determine the relative value and performance of same."

The pamphlet appears to fulfill the purpose excellently, giving directions, tables, diagrams and form sheets for recording results.

No. 1017. **Hoisting Engines.**—The John F. Byers Machine Co., Ravenna, O.

This catalog illustrates and gives sizes, capacities, etc., of a full line of hoisting engines, general locomotives, derrick cars, derrick irons, hand powers and blocks and sheaves. Contractors and quarrymen should have it on file.

No. 1018. **Digging Machinery.**—The Hayward Co., New York, N. Y.

This is a handsomely printed and illustrated book on Hayward orange peel buckets, clam shell buckets, railroad excavators, derrick fixtures, steel traveling derricks, dredges, skid excavators and coal handling machinery. The illustrations show orange peel and clam shell bucket excavating and coal handling outfits of a great variety of styles. Each illustration is accompanied by descriptive text which often gives actual output records besides describing the plant.

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Dec. 16. Columbus, O.....	Nov. 18
Dec. 16. Columbus, O.....	Nov. 23
Dec. 17. Martinsville, Va.....	Dec. 16
Dec. 17. Pottawatomie, Kan.....	Dec. 16
Dec. 18. Cincinnati, O.....	Dec. 2
Dec. 18. Sacramento, Cal.....	Dec. 16
Dec. 19. Batesville, Ark.....	Dec. 9
Dec. 21. Doylestown, Pa.....	Dec. 9
Dec. 22. Amsterdam, N. Y.....	Dec. 16
Dec. 23. Lock Haven, Pa.....	Dec. 16
Dec. 24. Sumner, Wash.....	Dec. 2
Jan. 1. Newport, Ore.....	Dec. 16
Jan. 5. Fairport, N. Y.....	Dec. 16
Jan. 8. Salt Lake City, Utah.....	Dec. 9
Jan. 12. Geneva, Neb.....	Dec. 16
Jan. 12. Rensselaer, Ind.....	Dec. 16

Buildings.

Dec. 16. San Jose, Cal.....	Nov. 25
Dec. 16. Oakland, Cal.....	Dec. 2
Dec. 16. Pensacola, Fla.....	Dec. 2
Dec. 16. Providence, R. I.....	Dec. 9
Dec. 16. White Plains, N. Y.....	Dec. 9
Dec. 17. Circleville, O.....	Dec. 2
Dec. 17. Harrisonburg, Va.....	Dec. 9
Dec. 17. Cleveland, O.....	Dec. 9
Dec. 17. New York, N. Y.....	Dec. 16
Dec. 17. New York, N. Y.....	Dec. 16
Dec. 18. Madison, Wis.....	Nov. 18
Dec. 18. Columbus, O.....	Dec. 16
Dec. 19. Passaic, N. J.....	Dec. 2
Dec. 19. Carthage, O.....	Dec. 9
Dec. 21. Seattle, Wash.....	Nov. 18
Dec. 21. Cheyenne, Wyo.....	Dec. 2
Dec. 21. Hot Springs, S. Dak.....	Dec. 2
Dec. 21. Covina, Cal.....	Dec. 2
Dec. 21. Belle Plaine, Kan.....	Dec. 9
Dec. 21. Pensacola, Fla.....	Dec. 16
Dec. 21. New York, N. Y.....	Dec. 16
Dec. 22. Coldwater, Mich.....	Nov. 18
Dec. 22. Mount Weather, Va.....	Dec. 9
Dec. 22. Ramona, Okla.....	Dec. 9
Dec. 23. Jersey City, N. J.....	Dec. 2
Dec. 23. Porterville, Cal.....	Dec. 9
Dec. 23. Buffalo, N. Y.....	Dec. 16
Dec. 23. Utica, N. Y.....	Dec. 16
Dec. 23. Montreal, Que.....	Dec. 16
Dec. 26. Americus, Ga.....	Nov. 25
Dec. 26. San Jose, Cal.....	Dec. 2
Dec. 28. Lake Charles, La.....	Nov. 25
Dec. 28. Covina, Cal.....	Dec. 9
Dec. 28. Alexandria, La.....	Dec. 16
Dec. 29. Alton, Ill.....	Nov. 25
Dec. 29. Columbus, O.....	Dec. 16
Dec. 30. Moultrieville, S. C.....	Dec. 9
Dec. 30. Vernon, B. C.....	Dec. 16
Dec. 31. Fort Howard, Md.....	Dec. 9
Jan. 4. Sault Ste. Marie, Mich.....	Nov. 25
Jan. 4. Lisbon, O.....	Dec. 9
Jan. 5. Niles, Mich.....	Nov. 25
Jan. 5. Frankfort, Ky.....	Dec. 9
Jan. 6. Paris, Ill.....	Dec. 9
Jan. 6. Fort Slocum, N. Y.....	Dec. 9
Jan. 6. Fort Myer, Va.....	Dec. 16
Jan. 7. Johnson City, Tenn.....	Dec. 9
Jan. 8. Stillwater, Okla.....	Dec. 16
Jan. 9. Murfreesboro, Tenn.....	Dec. 9
Jan. 11. Gainesville, Fla.....	Dec. 16
Jan. 12. Warren, O.....	Dec. 16

Roads and Streets.

Dec. 16. Brooklyn, N. Y.....	Dec. 9
Dec. 17. Newton, N. J.....	Nov. 25
Dec. 17. Fort Myer, Va.....	Dec. 9
Dec. 17. Cleveland, O.....	Dec. 9
Dec. 18. Zanesville, O.....	Dec. 16
Dec. 21. St. Paul, Minn.....	Nov. 25

Dec. 21. Vicksburg, Miss.....	Dec. 16
Dec. 22. Opelousas, La.....	Dec. 9
Dec. 22. Princeton, Ill.....	Dec. 16
Dec. 23. Cleveland, O.....	Nov. 25
Dec. 23. Roanoke, Va.....	Dec. 9
Dec. 23. Pittsburg, Pa.....	Dec. 9
Dec. 23. Brooklyn, N. Y.....	Dec. 16
Dec. 23. Brooklyn, N. Y.....	Dec. 16
Dec. 23. Harrisburg, Pa.....	Dec. 16
Dec. 28. Anderson, Ind.....	Dec. 2
Dec. 30. Chambersburg, Pa.....	Dec. 16
Dec. 30. Greensburg, Pa.....	Dec. 16
Dec. 31. Kansas City, Mo.....	Dec. 16
Dec. 31. Uniontown, Pa.....	Dec. 16
Jan. 2. Griffith, Md.....	Dec. 16

Sewers.

Dec. 16. Baltimore, Md.....	Dec. 2
Dec. 16. Brooklyn, N. Y.....	Dec. 9
Dec. 17. Grand Rapids, Mich.....	Dec. 16
Dec. 18. Louisville, Ky.....	Dec. 2
Dec. 18. Columbus, Ohio.....	Dec. 16
Dec. 21. Green Bay, Wis.....	Dec. 9
Dec. 21. Muskogee, Okla.....	Dec. 9
Dec. 22. Mt. Vernon, O.....	Dec. 2
Dec. 22. Oxford, Ohio.....	Dec. 16
Dec. 23. Louisville, Ky.....	Dec. 16
Dec. 24. Galveston, Texas.....	Dec. 16
Dec. 27. Fort Wayne, Ind.....	Dec. 16
Dec. 28. Pipestone, Minn.....	Dec. 2
Dec. 28. West Allis, Wis.....	Dec. 16
Dec. 30. Louisville, Ky.....	Dec. 16
Jan. 7. Erie, Pa.....	Dec. 16

Water Supply.

Dec. 17. Brooklyn, N. Y.....	Dec. 9
Dec. 17. Hays, Kan.....	Dec. 16
Dec. 19. Fort McKinley, Me.....	Dec. 16
Dec. 21. Astoria, Ore.....	Nov. 25
Dec. 21. Astoria, Ore.....	Dec. 9
Dec. 21. Washington, D. C.....	Dec. 16
Jan. 12. Connersville, Ind.....	Dec. 2

Miscellaneous.

Dec. 16. San Jose, Cal.....	Power Plant, Etc., Nov. 25
Dec. 17. Fort Strong, Mass.....	Garbage Crematory, Dec. 2
Dec. 17. New York, N. Y.....	Pier Work, Dec. 16
Dec. 21. Pittsburg, Pa.....	Stone Steps, Walk, Etc., Dec. 16
Dec. 22. Jefferson Barracks, Mo.....	Electric Lighting System, Nov. 25
Dec. 22. Cleveland, Ohio.....	Retaining Walls, Dec. 16
Dec. 24. Fort Morgan, Ala.....	Sea Wall, Dec. 2
Dec. 28. Winnipeg, Man.....	Electric Plant, Dec. 9
Dec. 29. More Island, Cal.....	Wharf Work, Dec. 16
Jan. 4. Hartford, Conn.....	Street Lightning, Nov. 18
Jan. 4. Galveston, Texas.....	Metal Work, Dec. 16
Jan. 5. Boston, Mass.....	Refuse Disposal, Dec. 16
Jan. 6. West Union, Ia.....	Celk, Dec. 16
Jan. 15. Ottawa, Ont.....	Steamer, Dec. 2
Feb. 13. Hawaii.....	Dry Dock, Dec. 9

Excavation, Earth and Rock

Dec. 18. St. John, N. B.....	Dredging, Dec. 16
Dec. 21. Webster City, Ia.....	Ditch Work, Dec. 9
Dec. 22. Estherville, Ia.....	Ditch, Nov. 18
Dec. 22. Albany, N. Y.....	Barge Canal Wmk, Dec. 2
Dec. 29. Burlington, Ia.....	Ditch Work, Dec. 16
Jan. 9. Anoka, Minn.....	Ditch Work, Nov. 25
Jan. 9. Houston, Texas.....	Drainage Work, Dec. 16
Jan. 15. Mangum, Okla.....	Railroad Grading, Dec. 16

Materials, Machines, Supplies, Tools, Etc.

Dec. 16. New York, N. Y.....	Corporation Cocks, Dec. 9
Dec. 17. Washington, D. C.....	Pipe Fittings, Etc., Dec. 9
Dec. 17. Grand Rapids, Mich.....	Sluice Gates, Dec. 16
Dec. 17. New York, N. Y.....	Pike, Etc., Dec. 16
Dec. 18. Warren, Pa.....	Gas Engines, Generators, Dec. 9
Dec. 18. Williamsport, Pa.....	Fire Hose, Dec. 16
Dec. 21. National Soldiers' Home.....	Va.....Pumps, Etc., Dec. 2
Dec. 21. Burrwood, La.....	Ice Plant, Etc., Dec. 2

Dec. 21. Washington, D. C.....	Boilers, Cement, Etc., Dec. 2
Dec. 21. Hartford, Conn.....	Fire Hose, Dec. 16
Dec. 21. Pittsburg, Pa.....	Valves, Etc., Dec. 16
Dec. 21. Pittsburg, Pa.....	Filling Cabinets, Dec. 16
Dec. 22. Seattle, Wash.....	Lumber, Dec. 16
Dec. 23. Kansas City, Mo.....	Pump, Motor, Etc., Dec. 16
Dec. 28. Washington, D. C.....	Lumber, Jacks, Etc., Dec. 9
Dec. 28. Camaguey, Cuba.....	Pumping Plant, Dec. 9
Dec. 31. Washington, D. C.....	Powder Hoists, Dec. 9
Jan. 4. Fort Monroe, Va.....	Engines, Boilers, Etc., Dec. 9
Jan. 4. Washington, D. C.....	Steel, Iron, Drills, Etc., Dec. 16
Jan. 15. Portland, Ore.....	Portland Cement, Dec. 2
Feb. 22. Winnipeg, Man.....	Pump, Motor, Dec. 9

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Sacramento, Cal.—Until 2 p. m., Dec. 18, by Wm. B. Hamilton, County Clerk, for constructing 60 ft. steel bridge in Buckeye Valley on the Jackson Road.

Rensselaer, Ind.—Until Jan. 12, by Commissioners of Jasper and Porter Counties, at Rensselaer, for the construction of an iron bridge over Kankakee River. J. H. Leatherman is Auditor Jasper County.

Pottawatomie, Kan.—Until noon, Dec. 17, by L. M. Mullett, Clerk of Pottawatomie Township, Lane, Kan., for building stone abutments to bridge over Sac Branch south.

Geneva, Neb.—Until Jan. 12, by N. F. Stanard, Clerk of Fillmore County, for material and labor for constructing all county bridges for a period of one year.

Amsterdam, N. Y.—Until 1 p. m., Dec. 22, by W. Barlow Dunlap, for the erection of a two-span steel bridge across the Schoharie Creek, at Fort Hunter, N. Y., and two concrete abutments and one pier. Each span to be 228 ft. in length.

Fairport, N. Y.—Until noon, Jan. 5, by F. C. Stevens, State Superintendent of Public Works, Albany, N. Y., for Contract No. 38, Erie Canal, Sec. 9, for constructing the superstructure, substructure and approaches for a highway bridge at Wappings, 2.5 miles west of Fairport, N. Y., Station 2003-51.

Newport, Ore.—Until Jan. 1, by County Court of Lincoln County, for rebuilding bridge of Big Elk River at Elk City; bidders to furnish plans and specifications.

Lock Haven, Pa.—Until noon, Dec. 23, by County Commissioners, James A. Wensel, Clerk, for constructing steel span bridge with concrete floor over Fisher Creek in Porter Township. Certified check for \$500 required with bid.

Martinsville, Va.—Until Dec. 17, by J. R. Gregory, City Engineer, for construction of iron bridge across Smith River at Satterfield Ford site, near Martinsville.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Pensacola, Fla.—Until 3 p. m., Dec. 21 (extension of date), by F. F. Bingham, Pensacola, Secretary Pensacola Hotel Co., for the general construction of an 8-story fireproof hotel building. W. L. Stoddart, Architect, 31 Union Square, New York City.

Gainesville, Fla.—Until 3 p. m., Jan. 11, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. post office at Gainesville, Fla.

Alexandria, La.—Until Dec. 28, by Mayor and City Council, for erection of new city hall building.

Buffalo, N. Y.—Until 3 p. m., Dec. 23, by T. E. McGarr, Secretary State Commission in Lunacy, Albany, N. Y., for additions to Elmwood Building; additional verandas, wards 3, 4, 5 and 6; boiler room roof extension; construction, including heating, plumbing and electric work, at the Buffalo State Hospital, Buffalo. Franklin B. Ware, State Architect, Albany, N. Y.

New York, N. Y.—Until 3 p. m., Dec. 17, by Park Board, Arsenal Bldg., Central Park,

for erection of addition to Metropolitan Museum of Art, for the Boscawen Collection.

New York, N. Y.—Until 2 p. m., Dec. 17, by Robert W. Hebbard, Commissioner of Charities, for the excavation, masonry, steel and iron work, roofing and metal work, carpentry, electric work, heating and ventilating work, plumbing work and all other work, as set forth in the drawings and specifications of the construction and entire completion of a tuberculosis infirmary for the Metropolitan Hospital District, Blackwell's Island, Manhattan.

New York, N. Y.—Until 11 a. m., Dec. 21, by C. H. J. Snyder, Superintendent of School Buildings, for several contracts for alterations, repairs, etc., to various school buildings.

Utica, N. Y.—Until 3 p. m., Dec. 23, by State Commissioner in Lunacy, T. E. McGarr, Secretary, Albany, N. Y., for reconstruction, Ward No. 4, including heating, plumbing and electric work, also for renewal of plumbing, Infirmary Building, at the Utica State Hospital, Utica. Franklin B. Ware, State Architect, Albany, N. Y.

Columbus, O.—Until noon, Dec. 29, by the State Board of Agriculture, for the erection of a women's building on the State Fair Grounds, Dawson & Holbrook, Architects, Outlook Bldg., Columbus.

Columbus, O.—Until noon, Dec. 18, by Trustees of the Ohio Institution for Feeble-Minded Youth, Dr. E. J. Emerick, Secretary, Columbus, O., for the furnishing of the materials and the performing of the labor necessary to erect complete a barn at the Ohio Institution for Feeble-Minded Youth, Columbus. Frank L. Packard, Architect, Columbus, O.

Warren, O.—Until 3 p. m., Jan. 12, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. post office at Warren, O.

Stillwater, Okla.—Until noon, Jan. 8, by W. A. Etherton, for the erection of a boy's dormitory for the Oklahoma Agricultural and Mechanical College at Stillwater.

Fort Myer, Va.—Until 11 a. m., Jan. 1, by Capt. B. B. Iyer, Constructing Q. M., for construction of a veterinary stable at this post. Official advertisement will be found elsewhere in this issue.

Vernon, B. C.—Until Dec. 30 (extension of date) by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for erecting public building here.

Montreal, Que.—Until Dec. 23, by Alphonse Gagnon, Secretary, Department of Public Works, for completion of a new jail for the District of Montreal. Certified check for \$60,000 required with bid. Marchand & Brassard, Architects, 161 St. James St., Montreal.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Princeton, Ill.—Until 3 p. m., Dec. 22, by Board Local Improvements, Henry G. Paddock, Secretary, for materials and labor for grading, draining, curbing and paving with brick on Main St.

Griffith, Ind.—Until 7:30 p. m., Jan. 2, by M. J. Bierker, Town Clerk, for constructing cement sidewalk on Wood Ave.

Vicksburg, Miss.—Until 8 p. m., Dec. 21, by Mayor P. M. Harding, for paving Clay St. with vitrified brick, granite, bitulithic, asphalt and mineral rubber.

Kansas City, Mo.—Until 11 a. m., Dec. 31, by Harry P. Koehler, County Highway Engineer, for grading, macadamizing and constructing necessary drains on Levasy and Oak Grove Road, from Levasy south on said road about 3½ miles to the Campbell School House, near the center of Section 5, Township 19, Range 29.

Brooklyn, N. Y.—Until 11 a. m., Dec. 23, by Bird S. Coler, Borough President, for improvement of several streets by regulating, paving and repaving with asphalt, asphalt block and granite.

Brooklyn, N. Y.—Until 11 a. m., Dec. 23, by Bird S. Coler, Borough President, for curbing and laying sidewalks on several streets.

Zanesville, O.—Until Dec. 18, by Board Public Works, J. T. Hahn, Clerk, for grading, curbing and paving portions of McIntire Ave.

Uniontown, Pa.—Until Dec. 31, by State Highway Department, Harrisburg, Pa., for constructing 1,995 ft. of road in Fayette City, Fayette County.

Greensburg, Pa.—Dec. 30, by State Highway Department, Harrisburg, Pa., for con-

structing 18,500 ft. of road in Hempfield Township and 5,400 ft. of road in Penn Township, both in Westmoreland County.

Harrisburg, Pa.—Until noon, Dec. 23, by W. W. Caldwell, Commissioner Highway Department, for grading on 13th St.

Chambersburg, Pa.—Until Dec. 31, by State Highway Department, Jos. W. Hunter, Commissioner, Harrisburg, Pa., for constructing 12,100 ft. of road in Montgomery Township, Franklin County.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Fort Wayne, Ind.—Until Dec. 27, by Board Public Works, for constructing vitrified pipe sewer in alley east of Short St.

Louisville, Ky.—Until noon, Dec. 30, by Commissioners of Sewerage, J. B. F. Breed, Chief Engineer, Equitable Bldg., for the following work: Contract No. 18, Hoertz Ave., construction of 3,000 ft. of concrete sewer from 24 in. to 5 ft. in diameter, maximum depth about 25 ft. and including about 900 cu. yds. of concrete. Contract No. 19, Aublin Ave., construction of 1,540 ft. of 24 and 27-in. concrete sewer and the laying of 660 ft. of 20-in. pipe, including about 325 cu. yds. of concrete.

Louisville, Ky.—Until noon, Dec. 23, by Commissioners of Sewerage, J. B. F. Breed, Chief Engineer, Equitable Bldg., for Contract No. 17. The work will consist mainly of building a concrete sewer approximately of the following lengths: 1,125 ft. 27-in., 685 ft. 33-in., 730 ft. 63-in. and 680 ft. of 39-in., including about 700 cu. yds. of concrete.

Grand Rapids, Mich.—Until 8 p. m., Dec. 17, by Board Public Works, S. A. Freshney, Secretary, for furnishing and erecting sewage pumping station on Canal St. sewer. Certified check for \$50 required with bid.

Oxford, O.—Until noon, Dec. 22, by D. P. Beaton, Village Clerk, for the construction of a sewer disposal plant, consisting of a sedimentation tank, filter beds, automatic distributing machinery and controlling house. The Riggs & Sherman Co., Engineers, Toledo, O.

Columbus, O.—Until Dec. 18, by Board Public Service, E. W. Hirsch, Secretary, for constructing sewer in Mitchell St.

Erie, Pa.—Until noon, Jan. 7, by B. E. Briggs, City Engineer, for constructing sewer.

Galveston, Tex.—Until Dec. 24, by Board of City Commissioners, for constructing 4,500 ft. of reinforced concrete drain on Ave. M.

West Allis, Wis.—Until Dec. 28, by Board Public Works, F. Phillips, Jr., Chairman, for plans for septic tanks, filter beds or other disposal places for sewerage to complete the sewage system of the city, as heretofore adopted, plans of which system are now on file in the office of the City Clerk.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Hays, Kan.—Until noon, Dec. 17, by C. A. Harkness, City Clerk, for extensions of the water works system, consisting of concrete pump pit, furnishing and installing oil engines connected to triplex pumps and approximately 1½ miles of cast-iron pipes, special castings, etc.

Fort McKinley, Me.—Until Dec. 19, by Capt. F. J. Morrow, Quartermaster U. S. A., Portland, Me., for sinking deep wells at this post.

Washington, D. C.—Until noon, Dec. 21, by the District Commissioners, for equipping an auxiliary water system and fire protection for the Home for the Aged and Infirm, subdivisions of Bellevue and Blue Plains, D. C. Specifications, etc., at the office of the Chief Clerk of the Engineer Department, Room 427, District Bldg.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Burlington, Ia.—Ditch Work.—Until Dec. 29, by Supervisors of Louisa and Des Moines Counties at office of D. P. Hill, County Auditor, for constructing open ditch from Gates Lake to Iowa Slough, 2,500 ft., and a timber bulkhead with 36-in. cast iron outlet pipe and flap valve. This work was originally advertised for Dec. 15. Harman Engineering Co., Engineers, Peoria, Ill.

St. John, N. B.—Dredging.—Until 4 p. m., Dec. 18, by Nap. Tessier, Secretary Depart-

ment Public Works, Ottawa, Ont., for dredging at York Point and Ballast Wharf, St. John Harbor.

Mangum, Okla.—Railroad Grading.—We are advised that the Colorado, Texas & Mexico R. R. has a 25-mile grading contract to let between Jan. 1 and Jan. 15. The grading to be done is between Mangum, Okla., on the Rock Island Ry., and Oustee, Okla., on the Frisco. The grading is all light dirt work. Geo. D. Locke, Mangum, Okla., is Vice President and General Manager.

Houston, Tex.—Drainage Work.—Until Jan. 9, by Drainage Commissioners, Harris County Drainage District No. 1, at office of George C. Horton, Drainage Engineer, Theater Bldg., Houston, Tex., for about 350,000 cu. yds. of ditching, depth 4 to 5 ft., base 4 to 20 ft., with 1 to 1 slope.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Mare Island, Cal.—Wharf Work.—Until 10 a. m., Dec. 29, by Bureau Supplies and Accounts, Navy Department, Washington, D. C., for extending wharf at Navy Yard, Mare Island. Applications should refer to Schedule 623.

West Union, Ia.—Cells.—Until 2 p. m., Jan. 6, by J. L. Scallan, County Auditor, for furnishing county with six tool proof cells, one female cell, one juvenile cell and 20 window gratings.

Boston, Mass.—Refuse Disposal.—Until noon, Jan. 5, by Guy C. Emerson, Superintendent of Streets, for the erection and operation on the property of the city at Fort Hill Wharf, of a plant for the disposal by incineration of portions of the combustible waste, to be separated from city refuse, delivered at the plant. Alternate proposals will be received by the basis of disposal of refuse as above indicated, the contractor to erect a dumping station at Fort Hill Wharf and incinerating plant in vacant building near the Pumping Station at the Cow Pasture, so called, in Dorchester, the screened ashes and clinker to be disposed of by the contractor.

New York, N. Y.—Pier Work.—Until noon, Dec. 17, by Allen N. Spooner, Commissioner of Docks, Pier A, Battery Pl., for repairing and rebuilding portion of West 35th St. pier.

Cleveland, O.—Retaining Walls.—Until noon, Dec. 22, by A. R. Callow, Secretary Board Public Service, for constructing stone and concrete retaining walls in Rockefeller Park. Work will be let in three sections. Certified check for \$500 required with bid.

Pittsburg, Pa.—Stone Steps, Wall, Etc.—Until 10 a. m., Dec. 21, by A. B. Shepherd, Director Public Works, for the construction of new stone steps, retaining wall and grading at Bailey Ave. entrance, Grandview Park.

Galveston, Tex.—Metal Work.—Until noon, Jan. 4, by the Light-House Engineer, Mobile, Ala., for furnishing materials and labor of all kinds necessary for the construction and delivery of the metal work for Galveston Jetty Light Station, Tex.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Hartford, Conn.—Fire Hose.—Until 11 a. m., Dec. 21, by Board of Contract and Supply, for furnishing 2,000 ft. of 2½-in. rubber lined hose.

Washington, D. C.—Steel, Iron, Drills, Etc.—Until 10:30 a. m., Jan. 4, by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing, under Circular 484, steel, iron, yellow metal, sulphate of copper, copper tubing, bolts, rivets, nuts, twist drills, screws, spikes, staples, iron washers, wire, flanges, brazing unions, steel sockets and sleeves, lathe dogs, taps, reamers, dies, steel brushes, dollies, anvils, punches, wrenches, pliers, bench clamps, saw frames, tinners shears, oilers, coat hooks, hooks and eyes, locks, hinges, latches, drawer knobs, shutter sets, shelf brackets, dowel pins, pulleys, hose attachments, coal baskets, sinks, safes, food choppers, leather, belt lacing, packing, ship's felt, thread, crayons, lye, soap, rubber boots and gloves, etc.

Grand Rapids, Mich.—Sluice Gates.—Until 8 p. m., Dec. 17, by Board Public Works, S. A. Freshney, Secretary, for furnishing sluice gates for the Canal St. sewage pumping station. Certified check for \$50 required with bid.

Kansas City, Mo.—Pump, Motor, Etc.—Until Dec. 23, by Board Public Works, J. L.

Darnell, City Engineer, for installing a gate valve, pump, motor, etc., and the necessary appurtenances thereto, on the Joint District Sewer in Joint Sewer District No. 237, 238 and 239, in Sewer District No. 1, near the bank of the Missouri River.

New York, N. Y.—Pipe, Etc.—Until 2 p. m., Dec. 17, by John H. O'Brien, Commissioner Water Supply, Gas and Electricity, 13 Park Row, for furnishing and delivering cast iron water pipe, branch pipe and special castings for high pressure fire service.

Williamsport, Pa.—Fire Hose.—Until noon, Dec. 18, by J. J. Galbraith, Clerk, for furnishing 600 ft. of fire hose.

Pittsburg, Pa.—Filing Cabinets.—Until 10 a. m., Dec. 21, by A. B. Shepherd, Director Public Works, for furnishing and placing steel filing cabinets in the office of the clerk to the board of viewers, Municipal Hall.

Pittsburg, Pa.—Valves, Etc.—Until 10 a. m., Dec. 21, by A. B. Shepherd, Director Public Works, for furnishing and installing ten outlet rate controller valves and indicating and recording apparatus and appurtenances in the extension of the filtration works of the city. Bond for \$6,000 required with bid.

Seattle, Wash.—Lumber.—Until Dec. 22, by Major W. S. Wood, Q. M., U. S. A., Seattle, for furnishing and delivering at Seattle or Tacoma, 2,000,000 ft. of fir lumber and 60,000 ft. of hardwood, for shipment to Manila, P. I.

CONTRACTS LET.

The following contracts have been let recently:

Bessemer, Ala.—Street Work.—Huey Bros., Bessemer, for cherting, slaying and grading 4th Ave. for seven blocks.

Hamburg, Ark.—Bridge.—Vincent Bridge Co., New Orleans, La., at \$7,991, for erecting bridge over Bayou Bartholomew at Parkdale.

Oakland, Cal.—Fire Engine Houses.—Healy-Tibbetts Construction Co., for erecting two fire engine houses for city.

San Francisco, Cal.—Sewer.—Hanrahan-Erhardt Co., at \$78,847, for constructing north portion of the East Potero intercepting sewer.

San Francisco, Cal.—Fire Cisterns.—P. H. Mahoney, at \$20,305, for constructing five new fire cisterns for city.

Sacramento, Cal.—Sewers, Paving.—E. Twiddle for building sewers in the alleys P and Q and S and T Sts., 16th and 17th; Hilmer & Lawrence, at \$1,197, for improving the intersection of Front and I Sts. with basalt blocks.

San Francisco, Cal.—School.—Kittle Construction Co., 82 Second St., at \$101,500, general contract, for constructing new mission grammar school.

Yuba City, Cal.—School House.—Marders & Heere, for building school house in Barry School District.

Glenwood Springs, Colo.—Bridge.—Sheeley Bridge Co., Denver, Colo., at \$26,870, for constructing steel bridge for county over Grand River at Rifle. Bridge will have two spans—240 ft. and 190 ft.

Pueblo, Colo.—Bridge.—Henry M. Fox, Florence, Colo., for building bridge on Kansas-Colorado electric road between Pueblo and Turkey Creek.

Las Animas, Colo.—Bridge.—Pueblo Bridge Co., Pueblo, Colo., at \$6,400, for building a 200-ft. bridge over the Purgatory River near Las Animas.

Pueblo, Colo.—Bridge.—Pueblo Bridge Co., Pueblo, Colo., at \$5,475, for constructing reinforced concrete bridge over the St. Charles River for the county.

Washington, D. C.—Building Work.—The G. A. Fuller Co. for the erection of the second addition to the McKinley Manual Training School at Seventh and Rhode Island Aves., to cost \$60,000.

Red Oak, Ia.—Library.—L. D. Ashby, for general contract for erection of 2-story library building to cost \$12,000.

Des Moines, Ia.—Electric Railway.—American Engineering Co., Charles N. Wilson, President, Terminal Bldg., Indianapolis, Ind., is stated to have been awarded the contract for the 196-mile electric line of the Des Moines & Sioux City Ry. Co.

Aurora, Ill.—Church.—Louis Sylvester & Son, for erecting new church at Pierce St. and North Lincoln Ave.

Freeport, Ill.—Bridges.—Wm. H. Shons, Freeport, for erecting six bridges over Apple River in Rush Township.

Moline, Ill.—Water Mains.—Plambeck Construction Co., for constructing 6-in. water main in 18th Ave.

Yorkville, Ill.—Reservoir.—Rich & Carlson, Fort Dearborn Bldg., Chicago, Ill., at \$5,968, for constructing concrete reservoir.

Fort Wayne, Ind.—Concrete Work.—National Concrete Co., at \$7,150, for constructing concrete water course along the tracks of the Toledo & Chicago Interurban road.

Louisville, Ky.—Walks.—E. E. Peterson, at \$1,266, for constructing granitoid walks around the court house in this city.

Louisville, Ky.—Sewer.—Citizens Trust & Guarantee Co. is stated to have taken over the contract for completing Sec. A of the outfall sewer at 24th and High Sts., and will have the work completed by Coupe & Gray, Resident Engineers. Contract amounts to about \$30,000.

Plaucheville, La.—Bridge.—Oger Lecour for constructing bridge over Bayou Leaublue.

Houghton, Mich.—Addition to Jail.—F. J. Hall for erecting addition to county jail.

Owosso, Mich.—Railroad Work.—J. J. Byers & Co., Houghton, Mich., for constructing seven miles of railroad from the New Haven Coal Mining Co.'s property to Owosso.

Crookston, Minn.—Building Work.—Northern Construction Co., Milwaukee, Wis., at \$68,884, for erecting 1½-story stone post office building here.

St. Paul, Minn.—Steel Construction.—A. Bolter's Sons, 84 La Salle St., Chicago, Ill., for the steel construction of the new hotel to be erected in this city.

Missoula, Mont.—Bridge.—Burrell Bridge Co., Oakland, Cal., at \$134,716, for constructing bridge over the Missoula River at Higgins Ave.

St. Joseph, Mo.—Building.—P. P. Buddy, 501 Main St., for erecting new Robidoux School at 10th and Edmond Sts., to cost \$120,000.

Newark, N. J.—Paving.—J. F. Shanley Co., at \$89,585, for paving Market St. with the U. S. creosoted wood paving blocks. Work has been held in abeyance since Sept. 17.

Columbus, Mont.—Bridge.—Security Bridge Co., Minneapolis, Minn., at \$19,900, for erecting bridge over Yellowstone River near Columbus.

Hillsdale, N. J.—Macadamizing.—H. B. Sproul, Peekskill, N. Y., at \$18,506, for grading and macadamizing here.

Auburn, N. Y.—Sewer.—Peter Dyrnes, at \$1,485, for constructing sewer in Fulton St.

Rochester, N. Y.—Bridges.—W. J. Burns Co., Syracuse, N. Y., at \$30,970, for constructing bridge over Erie Canal at Lyell Ave.; M. Fitzgerald, Hoosick Falls, N. Y., at \$29,889, for constructing bridge over Oswego Canal at North Salina St. Both bridges are to be of the bascule type.

Rye, N. Y.—Sewer System.—David Peoples, Betz Bldg., Philadelphia, Pa., at \$290,075, for constructing sewer system for this place.

Dayton, O.—Sewers.—William Boyd, at \$1,876, for constructing sanitary sewer in Stillwater Ave.; George Hecker, Jr., at \$4,154, for constructing storm water sewer in Wyoming St.

East Piqua, O.—Sewer.—Backus Construction Co., Reibold Bldg., Dayton, O., at \$5,788, for constructing storm sewer.

Palston, O.—Bridge.—Missouri Valley Bridge & Iron Co., Leavenworth, Kan., at about \$13,000, for constructing steel bridge over the Arkansas River, near Ralston, for Pawnee and Osage Counties.

Walter, Okla.—School Building.—D. K. McLeod, Lawton, Okla., for erecting school building for this city.

Chester, Pa.—Bridge.—Alonzo V. Baker, Media, Pa., at \$1,650, for building bridge in Middletown Township for county.

Chester, Pa.—Bridge Abutments.—John Hanna's Sons for building abutments for proposed bridge at Claymont for the Chester Traction Co.

Pittsburg, Pa.—Building.—Morrison Bros., at \$95,622, for constructing school building for Beltzhoover School Board.

Austin, Tex.—Bridge.—C. Q. Horton, at \$1,350, for building steel bridge over the Big Walnut Creek on the Austin and Manor Road.

Amarillo, Tex.—Building.—Texas Building Co., Fort Worth, Tex., for erecting 2-story station here for C. R. I. & P. Ry., to cost \$20,000.

Ogden, Utah.—High School.—Eccles Lumber Co., for constructing new high school building to cost \$125,000.

Salt Lake City, Utah.—Sidewalks.—Davis & Heuser, Salt Lake City, at \$5,034, for constructing sidewalk extension No. 141.

Wenatchee, Wash.—Water Works Extensions.—Ball & McMerney for installation of a pump and construction of the additions to the present water system.

Milwaukee, Wis.—Bridge.—Stack Dredge & Dock Co., Milwaukee, at \$139,785, for constructing bascule bridge at East Water St. Bridge will have a span of 130 ft. The total length of the bridge will be 270 ft. The roadway will be 37 ft. and the two sidewalks will be 12 ft. wide. The counterweights will weigh 500 tons. The trunnion will be 2 ft. in diameter and the distance from trunnion to trunnion will be nearly 155 ft.

Huntington, W. Va.—Building.—The A. N. Withrow Co., of Charleston, for the construction of the new Elk's home.

New Westminster, B. C.—Bridge.—Canada Foundry Co., at \$26,891, for superstructure and International Contract Co., Seattle, Wash., at \$29,642, for substructure of the New Westminster Lulu Island bridge.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States.

Montgomery, Ala.—County Board of Revenue has ordered an election to vote on issuing \$150,000 of bonds for road bridge work.

Pueblo, Colo.—Following bids were received Nov. 30 by County Commissioners for constructing a concrete bridge over the St. Charles River on the Vineland Road: Pueblo Bridge Co., \$5,475; Standard Construction Co., Pueblo, \$6,000; M. F. Levy Construction Co., Denver, \$6,220; W. L. Smith, Pueblo, \$7.85 per cubic yard for the concrete and extra for driving piles for abutments; Charles S. Sheely, Denver, \$5,175.

Stratford, Conn.—The town proposes to improve the Washington Bridge next spring.

Peoria, Ill.—Peoria & Pekin Union Railway, W. E. Emery, Chief Engineer, will begin work on its new bridge at this city next spring. Bridge will cost about \$525,000.

Streator, Ill.—City Council is to hold public hearing to discuss matter of building new bridge at Main St.

Bloomington, Ind.—County Commissioner and city authorities are to be asked to construct a new bridge over St. Maries River at Wells St.

Louisville, Ky.—Jefferson County Fiscal Court and Hardin County Fiscal Court have been in conference regarding the building of a steel bridge over Salt River at or near West Point. The bridge will cost about \$55,000, and as of this amount Hardin County would pay only \$8,000 the matter will probably be held in abeyance.

Baltimore, Md.—Westinghouse Church Kerr & Co., New York, have been retained by the Merchants & Manufacturers Association to make the survey and report upon the feasibility of the proposed bridge over the Chesapeake Bay.

Lansing, Mich.—City Engineer has prepared plans for a new bridge over Cedar River on Cedar St.; the estimated cost is from \$35,000 to \$40,000.

Joplin, Mo.—F. H. Blair has completed plans and specifications for the 3d St. viaduct. According to the plans the steel structure will have a total length of 1180 ft. and the width will be 43 ft. including the 28 ft. roadway, which is to be constructed of reinforced concrete with brick paving. The structure will rest on concrete pedestal, which the city is now constructing.

Kansas City, Kan.—Plans for new double track steel bridge which the Edge Water Terminal R. R. Co. is to construct over the Kaw River near its mouth for the use of the Missouri Pacific and Chicago Great Western Ry. companies have been completed. The bridge will be 734 ft. long and will cost about \$650,000. E. F. Mitchell, St. Louis, Mo., is Engineer of Construction for the Missouri Pacific.

Rochester, N. Y.—Bills will probably be introduced at the next session of the legislature providing for the construction of two additional canal bridges in this city by the state. One of these will be erected at Caledonia Ave. and the other at Emerson St.

Rochester, N. Y.—Bids were opened Dec. 3 by the State Superintendent of Public Works for constructing two lift bridges over the Erie Canal, one at Allen St. and the other Lisle Ave. M. Fitzgerald, Hoosick Falls, N. Y., at \$29,689, was the low bidder on the Allen St. bridge, W. J. Burns Co., Syracuse, N. Y., at \$30,970, was the low bidder for the Lisle Ave. bridge.

Manchester, N. H.—Resolution will probably come before the Common Council calling for a special appropriation for the erection of a new bridge over the Piscataquod River at the extension of Amory St.

Dayton, O.—Howard Klepinger, County Engineer, has prepared specifications for the

new concrete bridge to be built at Needmore Road by the County.

Dayton, O.—City Engineer Cellarius is preparing plans and estimates for a reinforced concrete bridge to be erected next spring by the city over the Miami River at Stewart St. Plans are also being prepared for the erection of a bridge at Antioch and Iowa Sts on the West Side.

Youngstown, O.—Plans are under discussion for the construction of the proposed Spring Common bridge.

Lima, O.—City proposes to build a new bridge on East High St. next year. O. E. Selby, Engineer of Bridges, Big Four Railroad, Cincinnati, O., is preparing plans.

Ellwood City, Pa.—The Local Board of Trade is considering the matter of trying to get a company to erect a toll bridge over the Beaver River to connect this city and Koppel.

Pittsburg, Pa.—Select Council has passed ordinances providing for an election to authorize a \$1,800,000 bond issue to build a bridge at 11th St.

Columbia, S. C.—County may hold an election to vote on issuing bonds for building a free bridge over the Broad and Congaree Rivers.

Houston, Tex.—Bridge Committee of which W. C. Munn, Tom Flaxman, Dave Burks and B. D. Harris are members, is considering plans for a viaduct 1,500 ft. long to begin at Travers St. in the 5th Ward. The estimated cost, according to the plans of H. L. Shaw, Engineer, is \$177,000.

Bellingham, Wash.—City Engineer is preparing plans for a reinforced concrete bridge to be erected over the Whatcom Creek at Grand Ave.

Milwaukee, Wis.—C. J. Poetsch, City Engineer, will at once prepare plans for the erection of \$125,000 bascule bridge at Michigan St.

Railroads.

Items Arranged Alphabetically by States.

Whitmore, Ark.—Helena, Parkin & Northern Ry. Co. has been incorporated with a capital stock of \$350,000 and proposes to build a railway from Whitmore to Marked Tree, a distance of 50 miles. The proposed route will require little grading, the cost of this being estimated at \$2,000 per mile. T. S. Hare, E. W. Sparrow, A. C. Stebbins and E. F. Cooley are interested.

Elberton, Ga.—Elberton Air Line R. R. has been purchased by H. V. Poor, of New York, for \$581,252, and will be operated as an independent line between Elberton and Tooele. The name of the road has been changed to the Elberton Southern.

Abbeville, Ga.—New York parties are considering constructing a railroad from Abbeville, Ga., to Winchester, Ga., passing through Hawkinsville. George W. Brannerman, of New York, who is interested in the project, is quoted in press reports as stating that the work would be started in January. Right-of-way from Hawkinsville to Grovania, which will be the first section constructed, has been secured.

Macon, Ga.—Central of Georgia Ry., C. K. Lawrence, Chief Engineer, Savannah, Ga., is planning to improve its shops and yards at this place.

Nampa, Idaho—Idaho Northern Ry., J. F. Barnes, Superintendent, Nampa, Idaho, proposes to build 100 additional miles of line.

De Kalb, Ill.—De Kalb-Midland Ry. Co., with principal offices in Chicago, Ill., has filed its articles of incorporation and proposes to construct a line from a point in or near the city of De Kalb, De Kalb County, to Sandwich, in the same county. The capital stock is \$150,000 and the incorporators are: John V. McQueen, Elgin, Ill.; Herbert J. Burdick, Elgin; Fred Cole, Chicago; Wm. G. Wilcox, Elgin, Ill., and John E. Pearce, Chicago.

Evansville, Ind.—Project for the Chicago, Indianapolis & Evansville R. R., proposed to connect the Ohio River with Lake Michigan, is to be revived, according to a statement of Joseph E. Henley, Bloomington, Ind., counsel for the promoters of the road. The company had local offices at Evansville, Ind., and advises from that place state that these offices will be reopened in the near future.

Pittsburg, Kan.—Advices from this city state that the Atchison, Topeka & Santa Fe Ry. is planning to build a cutoff south from Chippewa, through Weir City, to secure an entrance to Joplin.

Portland, Me.—Docks Nos. 1, 2 and 3 and freight sheds of the Grand Trunk Ry., H. G. Kelley, Chief Engineer, Montreal, Que., at this place were destroyed by fire Dec. 4, with a loss of \$150,000.

Marshall, Mich.—H. E. Hollon, Marshall, is promoting a project for the construction of a railroad from this city to Montpelier, O. The road is to be known as the Toledo, Marshall & Northern, and it is said that arrangements have been made for the disposal of construction and equipment bonds. The road, if built, will pass through Portland, Coldwater and other Michigan cities and towns, and connect with the Wabash at Montpelier. In Michigan the new road would cross nine different lines.

Cheboygan, Mich.—M. D. Olds, owner of about 30,000 acres of timber lands south and east of Cheboygan, has had surveys made for a railroad into his holdings from his mill in this city. The road will be about 20 miles long and will tap one of the largest standing timber belts left in Michigan. The road will likely be extended to Alpena, taking in Rogers City and the shore towns.

Natchez, Miss.—Committee has been appointed to raise \$50,000 bonus here for the Mississippi River Western R. R. which is projected to run from Meridian, Miss., to Natchez.

Ellisville, Miss.—Work is to be started at once, it is stated, on the construction of a railroad from Ellisville to Kola. The road is to be built for Mulford Parker, owner of the Ellisville Lumber Co., and the Kola Lumber Co., and will be used as a timber road as well as for general traffic. The road will later be extended to Shubuta and to Natchez.

East St. Louis, Ill.—The Egyptian Steam & Electric Ry. Co. has been incorporated and proposes to build a line from East St. Louis, Ill., to Metropolis. The incorporators are: Jerome Childers, Herrin, Ill.; John Edmonds, Hurst, Ill.; S. Snyder, Elkville, Ill., and E. J. McGraw and Wade Winchester, of Bush, Ill.

Long Island City, N. Y.—New York & Queens County Ry. Co., 9 Borden Ave., Long Island City, N. Y., proposes to extend its route from Debevoise Ave., or Second Ave., and Pierce Ave., Long Island City, thence southerly along Debevoise Ave., connecting with the company's track upon Jackson Ave.

Brooklyn, N. Y.—New York State Public Service Commission has granted the East River Terminal Co., William Butler Duncan, President, a certificate of necessity. The work includes the construction of freight warehouse and terminals, and will involve the establishment of wharf railways and the erection of a 12-story warehouse.

Mechanicsburg, Pa.—Cumberland Valley R. R., T. J. Brereton, Engineer, Chambersburg, Pa., has presented plans to the Town Council for its proposed track elevation through the town. The plans include the construction of five reinforced concrete bridges and involve the expenditure of about \$500,000, it is said.

McColl, S. C.—North & South Carolina Ry. Co. has been incorporated, with headquarters at McColl, S. C., and proposes to build a railroad, to be operated by steam, electricity or gasoline, from McColl to Dillon. W. R. Bonnal is President and S. O. Bauesfield, Secretary, both of Hamlet, N. C.

Wells, Nev.—Official announcement has been made that the Oregon Short Line, Wm. Ashton, Chief Engineer, Salt Lake City, Utah, is having surveys made for a new stretch of road 160 miles in length, from Twin Falls, Idaho, to Wells, Nev. The new road will be built as part of the Mindoka & Southern, a subsidiary company of the Oregon Short Line.

Montesano, Wash.—Surveys have been completed for the Grays Harbor & Columbia River R. R. and the company has begun condemnation proceedings at Montesano, Wash., to secure land for its right-of-way. The line is to extend from Kalama, Wash., west to the Pacific, with a branch line north to a terminal point in Grays Harbor.

Madison, Wis.—State Rate Commission held hearing Dec. 14 on the application of the Wisconsin & Northern R. R. Company, W. Cambier, Chief Engineer, Oshkosh, Wis., for a certificate of public convenience and necessity, covering the Neopit-Phlox extension. If the certificate is granted it is believed that the extension will be completed at an early day. Within a year it is reported the line will build an extension to Antigo.

Huntington, W. Va.—Press reports from this place state that capital has been subscribed for a new railway down the west side of the Guyandotte River into this city. The report states that surveys will be at once made and the contract let the latter part of the winter.

Sheridan, Wyo.—Montana, Wyoming & Southern R. R. has filed its articles of incorporation at Miles City, Mont. The capital stock is \$5,000,000 and the company proposes to build a railroad through Wyoming from Sheridan along the Tongue River and through Montana along the same river. R.

H. Walsh, W. G. Birkhauser, C. S. Robinson, E. M. Holbrook and Malcolm Moncreiffe are named as incorporators.

Winnipeg, Man.—The Great Northern Ry., A. H. Hogeland, Chief Engineer, St. Paul, Minn., has completed surveys for a line from the United States boundary in Winnipeg, and construction of the line will begin in the spring. The line runs from Emerson, on the east side of Red River, to St. Agathe, where it crosses to the west side and runs north-westerly to the \$1,000,000 terminal property on Ross Ave., Winnipeg.

Electric Railways.

Items Arranged Alphabetically by States.

Fayetteville, Ark.—City Council has granted a franchise for street car line and it is stated that work will soon begin. The line is to be constructed in connection with the proposed Interurban road between Fayetteville, Rogers, Springdale and Bentonville. The project is being promoted by Boston, Mass., parties.

Helena, Ark.—The local commercial club is taking steps to secure a street car system for this city.

Berkeley, Cal.—The Southern Pacific Railroad Co., Los Angeles, Cal., has asked the new town of Ocean View for a franchise to extend its proposed new Berkeley lines into that territory.

Fresno, Cal.—Advices from this place quote F. S. Granger, promoter of the Fresno-Hanford interurban line, as stating that work on the new road will be started Jan. 1. Bonds for the road are stated to have been sold. Geo. C. Chadwick will superintend the construction of the lines.

Pomona, Cal.—Work upon the construction of the proposed electric railroad through Claremont, Upland and Pomona is to be started as soon as the right of way is secured, according to advices from this city. William G. Kerckhoff, Los Angeles, Cal., is in charge of the financing and construction of the road.

Grand Junction, Colo.—Grand Junction Electric Railway Co., Mining Exchange Bldg., Colorado Springs, Colo., will construct about four miles of electric street railway in this city. Surveys have been completed and part of the material purchased.

Des Moines, Ia.—The American Engineering Co., Chas. N. Wilson, President, Indianapolis, Ind., has been awarded the contract for financing, surveying and superintending the construction of the Des Moines, Sioux City Interurban Railway. The proposed line is about 196 miles long and will be a part of the triangular system that is being constructed and connect Des Moines, Sioux City, Omaha and Council Bluffs.

Dubuque, Ia.—The project for the Plattsville & Interurban line has been revived and new articles of incorporation are to be filed. The line will be known as the Dubuque, Wisconsin & Illinois Railroad.

Freeport, Ill.—The Freeport-Dixon Electric Railway Co. has filed its articles of incorporation with nominal capital stock of \$2,500. This is the reorganization of the original company which was first started in Freeport a few years ago. The company proposes to construct an interurban line between Dixon and Freeport, a distance of 35 miles.

Cairo, Ill.—Cairo & St. Louis Railroad Co., the McKinley interurban project, has filed a mortgage for \$250,000 to be used in the construction of the new interurban line between Cairo and St. Louis.

Morris, Ill.—H. A. Fisher of Joliet, Ill., President of the Joliet & Southern Traction Co., which is making several extensions, is considering an extension of the line from Joliet to Morris.

Elgin, Ill.—Aurora, Elgin & Chicago Ry. Co., Charles Jones, Chief Engineer, Wheaton, Ill., proposes next year to rebuild and reconstruct the Grove Ave. street car line in Elgin.

De Kalb, Ill.—De Kalb Midland Ry. Co., with principal office in Chicago and capital stock of \$150,000, has been incorporated, and proposes to construct an electric railway from Sandwich to De Kalb. The incorporators include W. G. Wilcox, a prominent contractor of Elgin, Ill.; John W. McQueen and Herbert A. Burdick, of Elgin; Fred Cole and John F. Pierce, of Chicago.

Goshen, Ind.—Harry L. Weber, Bucyrus, O., is in charge of surveys for a proposed electric line between Kendallville and Goshen. The line will pass through Lagonia and Wakarusa.

Evansville, Ind.—The Tennis Construction Co., Philadelphia, Pa., is making surveys for the proposed line of the Evansville, Mt. Carmel & Olney Electric Railway. It is expected that surveys for the new line to Olney will be finished before spring, so that active

construction can begin in the summer. E. Q. Lockyear, Evansville, Ind., is Secretary.

Girard, Kan.—Girard, Coal Belt Electric Ry. is stated to be securing right-of-way for an extension of its line from Franklin south. Preliminary surveys are stated to have already been made.

Rockland, Me.—Rockland, South Thomaston & Owls Head R. R. Co. has been reorganized and its name changed to Rockland, South Thomaston & St. George in view of the contemplated extension to St. George. John L. Donohue, of Rockland, Me., is President.

Detroit, Mich.—Ordinance is before the City Council to grant franchise to the new Windsor Tunnel & Lake Erie Electric Ry.

Grand Forks, N. Dak.—Grand Forks Railway Co., recently incorporated, has secured nearly all its necessary capital from local parties and steps will shortly be taken for the construction of the road. E. J. Lander, C. F. Whitcomb and W. H. Kelsey are interested.

Rochester, N. Y.—Rochester & Manitou Beach Railroad Co., 32 White St., Rochester, N. Y., has been having surveys made from Manitou Beach to Hilton for a proposed extension of the present trolley system to that place.

Seneca Falls, N. Y.—The Geneva, Watertown, Seneca Falls & Cayuga Lake Traction Co. is seeking right-of-way through the town of Seneca Falls east to the shore of Cayuga Lake. The company is said to be planning to cross Cayuga Lake with a trolley line.

Gouverneur, N. Y.—Right-of-way has been granted between this place and Ogdensburg and it is probable that preliminary surveys will be started soon for an electric railway between these two places. L. G. DeCent, Watertown, N. Y., is interested.

Lincoln, Neb.—Citizens' Railway, Fraternity Bldg., Lincoln, is considering several extensions in and about Lincoln.

Akron, O.—Steps are being taken to finance the proposed electric interurban line between Akron and Youngstown, O. Tom L. Childs, Akron, O., is promoting the project.

Bellefontaine, O.—The project for construction of the Bellefontaine and Sidney traction line has been revised and it is stated that the road will be completed next spring. John T. Adams, Columbus, O., is promoter.

Springfield, O.—Grading has been started for the entrance of the Springfield-Washington Traction Co. into this city. It is expected that work of extending the line to Washington Courthouse and Millsboro will be started early in the spring. George W. Baker is president.

Cincinnati, O.—Location has been made and surveys completed for about 75 miles of the line of the Cincinnati, Wilmington & Xenia Traction Co., incorporated last April, for the purpose of building a line from Columbus, Wilmington, and thence to Cincinnati. The total length of the line will be about 130 miles. Henry Rohwer, St. Louis, is Chief Engineer. John N. Carswell, Philadelphia, Pa., is general agent of the company.

Scott, Pa.—Scott Street Railway Co. has been incorporated with a capital stock of \$20,000 and proposes to operate a five-mile line in Scott township, Allegheny County. W. E. Kusen, Pittsburgh, Pa., is President. August Stutez, Bellevue, Pa., and J. D. C. Miller, Sewickley, Pa., are interested.

Shippensburg, Pa.—Chambersburg, Green Castle & Waynesboro Street Railway Co., Chambersburg, has asked town council for a trolley franchise here.

Lebanon, Pa.—Lebanon & Southern St. Railway Co. was organized here on Dec. 5 for the construction of an electric railway from Campvilletown and Bismark to Lebanon, thence to Shaffertown and eastward. Option on most of the right of way for the proposed line has been secured.

Chattanooga, Tenn.—Fielding H. Yost, Ann Arbor, Mich., has been selected as general manager of the Great Falls River & Power Co., chartered to develop the power of Great Falls and to build an electric short line from Chattanooga to Nashville.

Tulsa, Okla.—The Western Transportation Co. of St. Paul, Minn., which proposes to build an interurban line from Tulsa to Oklahoma City has applied to the City Council for a franchise to build into this city. The route as surveyed a year ago will take the line through Sapulpa, Ogmulgee and several other important towns of eastern Oklahoma.

Fort Worth, Tex.—Col. Charles B. Duffy, St. Louis, Mo., has made a proposition to build an interurban railway from Fort Worth to Mineral Springs. The estimated cost is \$1,400,000, and Col. Duffy's proposition provides that a bonus of \$300,000 be raised.

R. H. McNatt and Stewart Harrison of Fort Worth, Tex., are interested.

Walla Walla, Wash.—Farmers' Traction Co. Dr. N. G. Blalock, president Rees Williams, Walla Walla, is raising \$250,000 as a starter toward the construction of the proposed electric line from Daton to Wallula.

Tacoma, Wash.—The Pacific Traction Co. is to decide soon on the construction of a new line to South Tacoma, Point Defiance, 15th street, and other sections.

Oconomowoc, Wis.—Milwaukee Light, Heat & Traction Co., Milwaukee, Wis., has applied to the City Council for franchise to lay its tracks from the city limits down Milwaukee street and West avenue to a point on the west limits of the city.

Oshkosh, Wis.—Wisconsin Electric Railway Co., John Bowers, chief engineer, Oshkosh, Wis., is considering making extensive improvements in Oshkosh. The company also proposes to extend the Oshkosh-Mora interurban line to Berlin next summer. The work if carried out will cost about \$500,000.

Milwaukee, Wis.—Milwaukee Electric Railway & Light Co. has submitted plans to the city for its proposed new street railway line to be built over Tulson street bridge next spring. The new line will run from Fulson to 27th and Center Sts.

Sewers.

Items Arranged Alphabetically by States.

Tuscaloosa, Ala.—Local press is advocating the installation of a new sanitary sewer system.

Little Rock, Ark.—E. A. Kingsley, Superintendent Public Works, has been requested to prepare estimates of a system of storm sewers for the city.

San Diego, Cal.—Ordinance has been passed appropriating \$5,000 for the construction of the University Heights sewer. The work will be done by day labor under the supervision of the Superintendent of Public Work. Ordinance has also been passed appropriating \$10,000 for the construction of sewers in Florence Heights.

Coalinga, Cal.—City Trustees have had estimates made for installing sewer system. Estimated cost is \$35,000.

Pasadena, Cal.—City Council is to be petitioned to call special election to vote on issuing bonds for building storm sewer system. About \$250,000 would be required.

Willits, Cal.—Town has voted to issue \$30,000 of bonds, part of which will be used for installing sewer system.

Americus, Ga.—Council has been petitioned to extend the sewer system in South Americus.

Shelbyville, Ind.—City Council is considering plans and specifications for proposed new sewer system. According to the estimates of the engineers, Riggs & Sherman, Toledo, O., the system will cost \$130,510.

Louisville, Ky.—Chairman Barrett of the Board of Public Works, is urging that City Council appropriate \$250,000 for the City Engineering Department to be used next year for the construction of small sewers.

Duluth, Minn.—City Engineer has estimated cost of a main sanitary trunk sewer in 54th Ave., east, at \$15,950.

St. Paul, Minn.—Board Public Works has reported in favor of constructing the Portland-Aldine sewer system. Work will probably cost \$131,000.

St. Joseph, Mo.—Board Public Works will award contract latter part of this month for extending the Patee St. branch of the Mitchell Ave. sewer from 31st st. to 32nd St. W. K. Seitz, Assistant City Engineer, prepared the plans.

Brooklyn, N. Y.—John J. Creem Co., at about \$150,000, was low bidder Dec. 2 for constructing Sec. 3 of the East 98th St. sewer.

Syracuse, N. Y.—City will award contracts soon for the construction of the proposed 17th Ward sewer, which according to estimates of City Engineer Allen is to cost \$62,000. The sewer will range in size from 24 in. by 36 in. to 36 in. by 57 in.

Rawson, O.—City Council has been petitioned to construct sewer in South Main St. **Springfield, O.**—M. J. Bahm, City Engineer, has submitted estimates for the construction of a number of sanitary drains. Largest piece of work calls for the construction of 6,700 ft. of sewer in Maiden Lane and Cedar St. to cost \$22,000. The City Engineer is also preparing estimates for the following work: Cleaning and straightening of Mill Run sewer and removing of two dams between Burt and North Sts.; continuation of the high level sewer in Main St.; storm sewer to drain the Highlands; storm water sewer from East St. to the Wheldon ditch; dredging of Buck Creek from Lime-

stone St. west and from Nelson St. to the Big Four tracks; low level sewer from Lagonda to the park.

Enid, Okla.—City has voted to issue \$250,000 of bonds, it is stated, \$125,000 of which will go for storm sewer construction and \$25,000 for septic tanks. The remainder will be used for water extensions.

Sellwood (P. O. Station Portland), Ore.—Sewer system to cost \$55,774 is to be built here next year.

Marcus Hook, Pa.—Borough Council is seeking site for the sewage disposal plant to be erected in connection with its proposed sewer system. A. F. Damm is Engineer.

Parkesburg, Pa.—Borough Council is considering installing sewage disposal plant to cost about \$10,000.

West Chester, Pa.—This place has voted against issuing \$150,000 of bonds for sewerage work.

Harrisburg, Pa.—M. B. Cowden, City Engineer, has reported to City Council that the proposed Market St. and 18th St. storm sewer will cost \$35,000.

Kingston (P. O. Station Wilkesbarre), Pa.—Borough Engineer has been instructed to prepare plans for extension of the sewer system.

Sewickley, Pa.—State Board of Health has directed this place to have plans prepared before July 1, 1909, for a sewage disposal plant.

Wilkesburg, Pa.—H. W. McIntosh, Borough Solicitor, has prepared ordinance to authorize a \$290,000 bonds issue for building a storm sewer for this borough. J. B. Frease is Borough Engineer.

Ipswich, S. Dak.—City Council has preliminary surveys made for the sewer system which it proposes to install in the spring.

Plankinton, S. Dak.—An \$8,000 bond issue voted some time ago for a sewer system has been declared legal, and work of installing the system will at once be taken up.

Dallas, Tex.—Construction of a storm sewer in Calhoun, Market and other streets to cost \$4,150 is to be taken up at once.

Provo, Utah.—City Council has adopted plans of A. F. Parker, City Engineer, Ogden, Utah, for a new sewer system for this place.

Bellingham, Wash.—Resolution is before Council calling for the extension of the big Champion St. tunnel sewer, to provide for that portion of the city now draining into Whatcom Creek. The extension sewer will run from the end of the tunnel at Unity St., parallel Whatcom Creek for a portion of the way, and terminate at Nevada St.

TRADE NOTES.

The nine buildings of the Root & Van Dervoort Engineering Co. and the Moline Automobile Co., allied concerns of East Moline, Ill., have been equipped with a new sprinkler system at a cost of \$15,000.

Arthur Koppel Co., Machesney Bldg., Pittsburg, Pa., has turned over the agency for the sale of its portable track, industrial railways, cars of all kinds, including mine cars, rails, switches, turntables, etc., in the State of Colorado to the Jeffrey Manufacturing Co., 1711 Tremont Place, Denver, Colo.

Schalkebach & Budke, Structural Iron Work, 402 Claremont Ave., Jersey City, N. J., announce the complete equipment of their plant at Westside Ave. Station on the Central Railroad of New Jersey, Jersey City, and that they are now prepared to furnish details and submit estimates on all kinds of general and structural iron work.

The Edison Portland Cement Co., 1133 Broadway, New York, is planning to have a very interesting exhibit at Convention of the National Association of Cement Users at Cleveland, O., Jan. 11-16. Among other many interesting things in connection with the manufacture of Edison Portland cement, the company expects to put on exhibition a number of sample castings of the famous Edison poured concrete house.

The Teredo-Proof Paint Co., New York, has an order from the Charlotte Harbor & Northern for paint to treat 500 piles to be used for a wharf in Florida. The paint is to be applied in four coats, which, it is considered, will be sufficient to protect the timber from teredos. The cost of material and application will be about 10 cents per lineal foot. The B. & A. R. R. has also specified Teredo-Proof paint to be used on all timber work on the new Cunard Line Docks at Boston, Mass.

The physical effects of the Southwestern Bridge Co., Joplin, Mo., will be offered for sale at 1 p. m., Dec. 22, by W. B. Kane, Trustee for the company. The sale includes all of the real estate, buildings, furniture, material, tools and equipment of the above

concern, including approximately four acres, located on the St. Louis & San Francisco R. R., office building, machine shop and steel structural shop; also approximately 2,250 tons of steel plate, bars and structural steel, tools and equipment.

The partnership heretofore existing between John W. Page and E. R. Shnable, doing business as Page & Shnable, Engineers and Contractors, with office at 1002 Security Bldg., Chicago, Ill., has, by mutual consent, been dissolved. All outstanding accounts due to the scraper-bucket business will be collected by John W. Page, who will also pay all bills on the scraper-bucket account. All outstanding accounts due to the contract business will be collected by E. R. Shnable, who will also pay all bills on the contract account.

Ernst Wiener Co., Railroad Specialists for all Industries, announce that Mr. J. N. Richards, who for the last 14 years was General Sales Manager for the Standard Paint Co., has associated himself with them. Mr. Richards is well known amongst the large manufacturing interests of the country and his many friends and long experience will no doubt be the means of increasing the business of the well known concern with whom Mr. Richards is now connected. Mr. Richards will make his headquarters for the present at the main office, 50 Church St., New York City.

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Tracklaying by Machinery

SIMPLE—RAPID—ECONOMICAL

D. F. HOLMAN
RAILWAY TRACKLAYER COMPANY
1718 Railway Exchange, Chicago

IMPROVEMENTS TO WATER WORKS.

Connersville, Ind.

Notice is hereby given that the City of Connersville, Indiana, will on the 12th day of January, 1909, at 7:30 o'clock p. m., receive proposals for the construction and leasing to said city of certain improvements and additions to the City Water Works and water supply of said city, according to specifications on file in the City Engineer's office.

All proposals to be in the form of an offer to purchase real estate on which to construct pipe lines, pumping station and other things, and to lease all of such property to the city for a term of years, not less than ten (10) nor more than twenty-five (25), at an annual rental to be specified in proposal and providing for the right of said city to purchase said property and water supply at the end of term of years for a fixed price to be therein specified.

Such proposal shall be accompanied by plans and specifications showing style of structure and machinery to be erected specified, together with the contract or lease. The lessor to guarantee the maintenance of the source and supply of water.

Proposals to be accompanied by good bond, payable to said city in the penal sum of one hundred thousand dollars (\$100,000), conditioned that said lessor will complete said additions in accordance with terms of specifications and guarantee the maintenance of said source of water supply during term of lease.

The city reserves the right to hold any or all proposals open to acceptance until one is accepted according to the method prescribed by law.

JACOB S. CLOUDS,
City Clerk.

K. L. HANSON, Engr.

PROPOSALS FOR CONSTRUCTION OF barracks and quarters, and plumbing and heating and electric wiring same. War Department, office of the Constructing Quartermaster, New London, Conn., November 28, 1908. Sealed proposals for constructing one double barrack, one single barrack, two field officers' quarters, one four-set officers' quarters, two lieutenants' quarters, three double non-commissioned officers' quarters, and one double firemen's quarters, at Fort Terry (Plum Island), New York, and two double barracks, two field officers' quarters, four lieutenants' quarters, two double non-commissioned officers' quarters, and two double firemen's quarters, at Fort H. G. Wright (Fisher's Island), New York, and for plumbing, electric wiring and installing heating plants in same will be received here until 10 a. m., Feb. 10, 1909, and then opened. Proposals are desired for brick construction of all buildings and for reinforced concrete construction on bidders' plans of barracks and non-commissioned officers' and firemen's quarters. Information furnished on application. Envelopes containing proposals should be endorsed: "Proposals for Public Buildings," and addressed: "R. M. Schofield, Major, Q. M., Constructing Quartermaster, New London, Conn."

OFFICE OF THE QUARTERMASTER, Jefferson Barracks, Mo., November 23, 1908. Sealed proposals, in triplicate, will be received here until 11 a. m., December 22, 1908, and then publicly opened for a complete electric lighting system, consisting of the following items: Wiring buildings, constructing pole lines, furnishing electric fixtures, transformers and apparatus. Also to furnish electric current for lighting will be received. Information furnished on application. United States reserves the right to accept any or reject all bids. Envelopes containing proposals should be endorsed "Proposals for an electric lighting system," addressed to CAPT. O. W. BELL, Q. M.

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WILBUR J. WATSON, Member Am. Soc. C. E.
Expert Designer and Inspector of Bridges
Citizens Building Cleveland, Ohio

FORT MYER, VA., DECEMBER 3, 1908. Sealed proposals in triplicate will be received at the office of the Constructing Quartermaster, until 11 o'clock a. m., December 17, 1908, and then opened, for the reconstruction of paving and gutters around artillery stables. Certified check or Surety Company's guarantee for ten per cent of the amount must accompany each bid. Plans and specifications will be furnished on application. The government reserves the right to reject any or all bids. Proposals should be indorsed "Proposals for paving and gutters," and addressed to Captain B. B. Myer, Constructing Quartermaster.

GAS AND ELECTRIC PLANT.

Chillicothe, Mo.

Proposals wanted for the construction of a Gas and Electric Light Plant for street and private lighting, with day current, in Chillicothe, Missouri, a city of eight thousand; fifteen-year franchise. All communications should be addressed to City Clerk.

H. I. SPENCE, City Clerk.

24-in. CONCRETE AND STEEL WATER MAIN.

Astoria, Oregon.

Sealed bids will be received until noon, December 21, 1908, at the office of the Water Commission in Astoria, Oregon, for furnishing the material and constructing about 12,000 feet of 24-inch concrete water pipe, and about 1,300 feet of steel water pipe and furnishings, according to specifications on file in the Water Commission Office in Astoria. All bids to be accompanied by certified checks for ten per cent of the amount of the bid. The right is reserved by the Water Commission to reject any or all bids.

CITY WATER COMMISSION.

C. S. WRIGHT, Chairman.

FORT MYER, VA., DECEMBER 8, 1908. Sealed proposals in triplicate will be received at the Constructing Quartermaster's Office, until 11 o'clock a. m., January 6, 1909, and then opened, for construction of Veterinary Stable. Certified check or Surety Company's guarantee for 10 per cent of the amount must accompany each bid. Plans and specifications will be furnished on application, and a deposit of \$5.00 must accompany request to insure safe return. The Government reserves the right to reject any or all bids. Proposals should be indorsed "Proposals for Veterinary Stable" and addressed to CAPTAIN B. B. HYER, Constructing Quartermaster.

OFFICE OF THE CONSTRUCTING Quartermaster, Cheyenne, Wyoming, November 21, 1908. Sealed proposals, in triplicate, will be received at this office until 9:30 o'clock a. m. (Mountain Time), December 21, 1908, and then opened, for constructing at Fort D. A. Russell, Wyoming, buildings specified below, and for plumbing, steam heating, electric wiring and electric fixtures in buildings requiring same. Quarters for one brigadier general, three field officers, seven double captains, three double lieutenants, one bachelor officers, two double N. C. staff officers and two double cavalry barracks; four cavalry stables, one field staff and band stable, two fire stations, one guard house, two quartermaster's workshops, two coalsheds, one hayshed, two granaries, two quartermaster's store houses and two subsistence store houses. Plans and specifications can be examined at this office and full information given upon application. Plans and specifications are on file, for the inspection of bidders, in the office of: Chief Quartermaster, Department of the Missouri, Omaha, Nebraska; Department of Colorado, Denver, Colorado; Department of the Lakes, Chicago, Illinois, and at the office of the Secretary of the Builders' Exchange, St. Paul, Minn. The United States reserves the right to reject or accept any or all bids or any part thereof. Envelopes containing proposals should be endorsed, "Proposals for Constructing, etc., of Buildings at Fort D. A. Russell, Wyoming," and addressed to Captain V. K. HART, 15th Infantry, Acting Quartermaster, U. S. Army, in Charge of Construction, Room 3, Keefe Hall, Cheyenne, Wyo.

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STORM SEWERS.

Muskogee, Okla.

The City of Muskogee, Oklahoma, will on December 21, 1908, receive bids for the construction of storm sewers, aggregating \$250,000. Plans and specifications may be examined at the office of the city engineer or may be obtained after Dec. 10 on payment of \$10. The work will be part brick, part vitrified pipe and part concrete. Monthly estimates in cash.

L. B. KINSEY,
City Engineer.**STEEL OR CONCRETE BRIDGE.**

Salt Lake City, Utah.

Sealed proposals will be received at this office until 8 o'clock p. m., January 8, 1909, for the work of constructing a steel or concrete highway bridge across the Jordan River at North Temple St.

Instructions to bidders, together with specifications and forms for contract and bond, can be obtained upon application at the office of the Board of Public Works or City Engineer.

The right is reserved to reject any and all bids.

By order of the Board of Public Works.
H. J. McMILLAN, Chairman.
LOUIS C. KELSEY, City Engineer.

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List of Contractors' Supplies.

If you wish catalogs of the leading manufacturers send us a postal card giving your address and business, and the list numbers, as shown below, of articles of which you want catalogs.

This will save you the trouble of writing a large number of letters. Should you later on have correspondence direct with the manufacturers, we shall appreciate it if you will state in your letters that you are indebted to this paper for the introduction. Such a statement will be mutually beneficial.

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See 375. | 493 Tar. | 494 Telegraph and telephone line equipment. | 495 Tents. | 496 Tie plates. | 497 Ties, steel. | 498 Tile, drain. | 499 Tile making machinery. See 308. | 500 Tile, partition. | 501 Tile, roofing. See 426. | 502 Tools, contractors'. See 100. | 503 Time keeping devices. See 92. | 504 Traction engines. See 166. | 505 Track laying machines. See 413. | 506 Track tools. | 507 Tracing cloth. | 508 Tramways, wire rope. See 60. | 509 Track materials, railway. | 510 Trench braces. | 511 Trench machines. | 512 Turnbuckles. | 513 Turntables. | 514 Turbines (water wheels). | 515 Turbines, steam. | 516 Twisted steel. | 517 Valves, steam. | 518 Valves, water. | 519 Vault lights. | 520 Ventilators. | 521 Ventilating apparatus. | 522 Wagon loaders. | 523 Wagons, dump. | 524 Waterproofing. | 525 Water softeners. | 526 Waterworks machinery and supplies. | 527 Well drills. 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The above is only a partial list of the headings in our Card Index. No matter what you want, TELL US and we will put you in prompt communication with the leading manufacturers, dealers or contractors.

IN WRITING to our Advertisers for CATALOGS or PRICES Please mention ENGINEERING-CONTRACTING

FOR SALE!

Modern Bridge Plant and Equipment

There will be offered for sale at the plant of the Southwestern Bridge Company, Bankrupt, Joplin, Missouri, on

December the 22nd, 1908, at Two O'clock P. M.,

all of the real estate, buildings, furniture, material, tools and equipment of the above concern, including approximately 4 acres, located on the St. Louis & San Francisco Railroad, office building, machine shop and steel structural shop; also approximately 2,250 tons of steel plate, bars and structural steel and the following tools and equipment:

- 1 12" **Punch**—capacity, $\frac{3}{4}$ " in $\frac{3}{4}$ ".
- 1 36" **Punch**—capacity, $\frac{3}{4}$ " in $\frac{3}{4}$ ".
- 1 Double 12" and 24" **punch**, capacity, $\frac{3}{4}$ " in $\frac{3}{4}$ ".
- 1 12" **Punch**—capacity, 1" in 1".
- 1 60" **Punch**—capacity, 2" in 1".
- 1 36" **Punch**—capacity, 2" in 1".
- 1 6" **Punch**—capacity, $\frac{1}{2}$ " in $\frac{1}{2}$ ".
- 1 **Horizontal Punch**, 8" throat—capacity, $\frac{3}{4}$ " in $\frac{3}{4}$ ".
- 1 **Double Angle Shear**—capacity, 6x6x1" angles.
- 1 **Bending and Straightening Machine.**
- 1 **Q & C Cold Saw**, with extra Milling Head.
- 1 1,500-Pound **Steam Hammer.**
- 1 50" **Head Rotary Planer.**
- 1 18x11x12" **Duplex Air Compressor.**
- 1 **Wall Radial Drill**—20' arm.
- 1 **Hendey 20" Shaper.**
- 1 **Ryerson Friction Saw**—500-volt D. C. Motor.
- 1 **Hendey 16" Lathe.**
- 1 2" **Reliance Bolt Cutter.**
- 1 1 $\frac{1}{2}$ " **National Bolt Cutter.**
- 1 **Set Special 8" Bending Rolls**—11" and 8" Rolls.
- 1 4' **Rotary Shear**—capacity, $\frac{3}{4}$ " Plate.
- 1 **National 1" Rivet Machine.**

Also a large number of miscellaneous tools, including Pneumatic Riveters, 500-volt Direct Current Motors, Bulldozer, Grinders, Wood Working Machinery, Furnaces, Scales, Boilers, Hoists, Trolleys, Forges and the additional hand and power tools used in a modern bridge shop. For further information address:

W. B. KANE, Trustee

Joplin, Missouri.

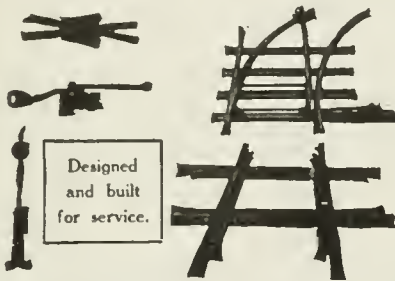
The Cincinnati Frog & Switch Co.

CINCINNATI, OHIO

Manufacturers of

Frogs, Crossings, Switches,
Switch Stands, Rail Braces,And special track work of every
description for Railroads, Mines,
Mills, Contractors, Plantations.

FROGS, SWITCHES, CROSSINGS

Stands and Portable Track for all weights of
rail for Quarries, Mines, Coal Tipples, Indus-
trial Plants and Contractors' use.Designed
and built
for service.

Catalogs and prices upon request

THE INDIANAPOLIS SWITCH & FROG CO.
SPRINGFIELD, OHIO

FOR SALE
400 Tons New Steel Channels
15 inches, 33 pounds, 30 feet long
We have the clamps for converting
them into steel sheeting.
Price Way Below Mills.
WALTER A. ZELNICKER SUPPLY CO., In ST. LOUIS

LOCOMOTIVES

Eight 9x14 saddle tank 36-inch
gauge. Also lighter and heavier
locomotives. Have 165 loco-
motives from 6 to 70 tons in
stock in our shops.

Also STEAM SHOVELS

Southern Iron & Equipment Co.
ATLANTA, GA.

Largest Dealers in Rebuilt Equipment in United States

EAST WORKS
New Freight and Passenger CarsWEST WORKS
Rebuilt Coaches, Cars and Engines

Hicks Locomotive & Car Works

General Offices Sales Dept.
Chicago Heights, Eastern Fisher Building,
Illinois Representatives Chicago, Ill.
Empire Steel & Equipment Co., 141 Broadway, New York.

**Steam Shovels, Locomotives,
Cars, etc.**
Contractors' and Railway Equipment
Telegraph, Telephone or Write Us.
A. C. TORBERT & CO.
647-648 Monadnock Block CHICAGO

VULCAN IRON WORKS
CHICAGO
PILE DRIVERS

"CONTINENTAL" DUMP CARS

1½ to 20 Cubic Yards Capacity,
any Gauge.

Continental Car & Equipment Co., (Inc.)

17 Battery Place, New York
Highland Park, Louisville, Ky.

WHICH appeals to you most, idle plant or
money in the bank? You would not
have idle plant had you been dealing with us
before your purchase. Are you sure the plant
you have will meet all the requirements of your
next piece of work? Is it not very probable
that you may use it to a disadvantage simply
because you are loathe to invest more money,
which in turn will be idle next year? Our
method should appeal to you. We have con-
tractors' equipment of all kinds. It will fit all
the conditions exactly. You can rent just what
you can use. Every piece of equipment you
are paying rental on is earning you something.
Remember nothing is lying idle and you have
no money invested.

Contractors

Have
you
idle
plant?

WRITE, WIRE OR CALL

UNITED STATES EQUIPMENT COMPANY

FISHER BUILDING, CHICAGO, ILL.

Motors For Sale

two 40 H. P. variable speed, 220 V. Jenny Motors. Complete with electric automatic control. Reasons for selling, too small. Adapted especially for printing press work or heavy machinery.

Address Purchasing Agt., Post-Dispatch, St. Louis, Mo.

Trench Machines

We sell and lease all kinds of Hoisting and Conveying Machines for Trench Work

Catalogue sent upon request.

CARSON TRENCH MACHINE CO.
BOSTON, MASS., U. S. A.

Branch Offices: 101 Warren Street, NEW YORK
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299 St. James Street, MONTREAL

WANTED—

you to know THE VELTEN UNIVERSAL CRUSHER is the only machine which will reduce the hardest ROCK and GRAVEL, instantaneously, to any fineness according to your wishes. It can be adjusted without stopping your machinery; is very simple in construction; less power and less repairs are required for maintenance expense, and the least cost of any machine in the market. Prices range from \$30 up. Investigate and you will be pleased

Address the

UNIVERSAL STONE CRUSHER CO.,
Cedar Rapids, Iowa.

Steam Shovels, Etc.

FOR SALE

Model 60 Marion (used 8 mos.)
" 20 " (" 11 ")
95-ton Bucyrus (" 10 ")
70 " " just rebuilt
65 " " " "
45 " " \$2,500
55 " " just rebuilt
10 " Industrial Crane (used 90 days) now in Chicago
9x14 Dinkies, 36" gage: 4 D. S. T.
10x16
12-yd., 5-yd. Standard gage; 4-yd. 36" gage Dump Cars; Standard gage Locomotives, etc.
No. 5 New McCully Crusher, also No. 5 Gates' Crusher.

FRED A. PECKHAM

1301-02 Great Northern Building, CHICAGO

GRUMIAUX



Our Leading Combinations

ENGINEERING-CONTRACTING.....	\$2.00	Our Price
Review of Reviews.....	3.00	
McClure's.....	1.50	
		\$3.60

ENGINEERING-CONTRACTING.....	\$2.00	Our Price
World's Work.....	3.00	
Everybody's.....	1.50	
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ENGINEERING-CONTRACTING

With Ainslee's.....	\$2.70
With American Boy and Success.....	2.65
With American Magazine and Etude.....	2.85
With Burr McIntosh Monthly.....	3.35
With Century.....	5.20
With Christian Endeavor World.....	2.45
With Cosmopolitan and Success.....	2.65
With Country Life.....	4.35
With Etude (for music lovers) and American.....	2.85
With Good Housekeeping and Cosmopolitan.....	2.65
With Harper's Bazaar and American.....	2.65
With Independent.....	2.70
With Leslie's Weekly.....	4.85
With Lippincott's.....	3.10
With Little Folks (new) and Cosmopolitan.....	2.65
With Metropolitan and American.....	2.65
With National Magazine and Success.....	3.00
With National Magazine and Sunset.....	3.00
With Outlook.....	2.70
With Photo Era and American.....	3.00
With Physical Culture and Cosmopolitan.....	2.65
With Scribner's.....	4.00
With Smart Set.....	2.70
With Travel Magazine and Success.....	3.00
With Van Norden Magazine and Pearson's.....	3.35
With Woman's Home Companion and American.....	2.65
With World Today and Cosmopolitan.....	3.00

ENGINEERING-CONTRACTING.....	\$2.00	Our Price
Review of Reviews.....	3.00	
Woman's Home Companion.....	1.25	
		\$3.35

ENGINEERING-CONTRACTING.....	\$2.00	Our Price
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World's Work.....	3.00	
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GRUMIAUX



The Magazine Man

LET ME TEACH YOU

The Magazine Subscription Game

A BUSINESS WITH A BIG FUTURE

How I Developed My Business from
\$47 to \$400,000 a Year

The subscription agency business is just beginning to develop, and every man and woman can learn it by my complete instructions, personally conducted by mail. You can in your leisure hours conduct a mail-order business that is dignified and earn large profits by the Grumiaux system.

Begin in a small way and watch it grow. The principles upon which I built my business become yours and the benefits of my 22 years' experience—you need not make the mistakes I did—the elements of success as I discovered them, my ideas, my schemes, all become yours through the Grumiaux system.

Year after year the renewal business increases profits, and before you know it you have a substantial business of your own. Start by working a few hours evenings.

Full particulars by mentioning this magazine.

Address all orders

ASK FOR OUR 84-PAGE CLUBBING CATALOGUE

THE GRUMIAUX NEWS AND SUBSCRIPTION CO., Le Roy, N. Y.

IN WRITING to our Advertisers for CATALOGS or PRICES Please mention ENGINEERING-CONTRACTING

WANTS

Undisplayed Cards under
this heading cost only
One Cent a Word
Displayed \$1.00 an Inch.

WANTED—POSITION, Engineer, 30; has level and transit with full field equipment. Address "Box 56," care of Engineering-Contracting, 355 Dearborn St., Chicago, Ill.

ENGINEER WANTED—One who can invest three thousand dollars in interurban railway. Good position for good man. Address Box 60, care of Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Second-hand Surveyor's or Engineer's Transit. Must be cheap and in first-class condition. State name of manufacturer and give catalogue number if possible. Enclose stamp for reply. M. C. Suttle, Junction, Ill.

WANTED—Can you control \$25,000 capital, or promote a company? The advertiser has a new proposition of merit in connection with the street and sidewalk pavement line. Address "M. F. J.," care of Engineering-Contracting, 355 Dearborn St., Chicago, Ill.

WANTED POSITION—Civil engineer; eight years' experience in municipal engineering, railway location and construction, real estate development, highway construction, land drainage. Address "E. S.," care of Engineering-Contracting, 355 Dearborn St., Chicago, Ill. 24-2t

WANTED—MASTER MACHINIST at \$7.04 per diem. A competitive examination will be held at the Navy Yard, Mare Island, Cal., January 7, 1909, to fill the above position. For application and further information address, "Commandant, Navy Yard, Mare Island, Cal."

CIVIL SERVICE COMMISSION of Chicago will hold examinations, open to non-residents as well as residents of the city, as follows: Engineering draftsmen, grade 6, on Dec. 22; architectural draftsmen, grades 5, 6, 7, on Jan. 4. Application blanks will be furnished upon request to Percy B. Coffin, Secy.

WANTED—POSITION as chemist or chemical engineer by graduate of leading technical school. Has had several years of practical experience and can fill responsible position. Best of references. Address Box "P. C.," care of Engineering-Contracting, 721 Park Row Bldg., New York City. 17-tf

WANTED—ENGINEERS AND CONTRACTORS—Do you need a man who can design structures for engineering works and superintend their proper erection? Have worked under instructions four years steady; graduate of M. I. T., Jr. Am. Soc. C. E. Good connections. Can talk business. Address Box 61, care of Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Can you control \$10,000 or promote a company? If so, the advertiser has a proposition in contracting machinery that is a labor saver and there is absolutely no competition. The machines can be built to order and be placed on the market at a large profit, leaving practically only the sales to be taken care of. Address 3338 17th, N. W., Washington, D. C.

WANTED—POSITION—Municipal and railway engineer, Mem. W. Soc. Eng., wants position with railway company or contract to make railway location, surveys or other engineering work. Experienced in special track design and construction, street paving and sewer work. Have field and office outfit. Address Box 62, care of Engineering-Contracting, 355 Dearborn St., Chicago, Ill.

WANTED POSITION — Business engineer, experienced in machine shop work, design installation and operation complete electric railway power and lighting systems and sales work. Expert in organization, cost keeping and analysis. Capable of taking complete charge of industrial works or large construction works and can get the best results. Cornell M. M. E. 1900, American member A. S. M. E., C. S. C. E., A. M. A. I. E. E. A hustler and business getter. Experience in Canada. P. O. Box 289, Kelowna, B. C.

WANTS

Undisplayed Cards under
this heading cost only
One Cent a Word
Displayed \$1.00 an Inch.

WANTED—Name and address of the party who on Nov. 24 wrote from Montreal requesting Bulletin of Dietrich wall form clamp, but omitted to sign his name to the request.

WANTED—POSITION—Engineer, 34, has transit, desires position on railroad or municipal work or with contractor or engineer; six years' experience on location and construction; hard worker. F. C. Randall, Hubbard, Ohio.

POSITION WANTED—By engineer with following qualifications: Total experience, 6 years, including field and office work, draughting, steel designing; 3 years resident engineer with railway and irrigation companies; university graduate; degree of B. Sc. Address Box 65, Engineering-Contracting, 355 Dearborn St., Chicago. 22-5t

WANTED—POSITION — Mechanical and construction engineer of initiative and executive ability with good business experience, buying, selling and shop work, desires to communicate with interested parties having any opening for a man of this description. Has been connected with some of the foremost mining and engineering organizations east and west.

Present salary \$5,000 per year; under contract until January first. Desires to locate permanently with suitable firm, investing with them in the enterprise if satisfactory. Address Box 66, care of Engineering-Contracting, 355 Dearborn St., Chicago. 22-5t

WANTED—SITUATION—Young man, technical graduate from first-class university, desires honorable position with engineer or construction company. Middle or north-west preferred. Address Box 74, care of Engineering-Contracting, 355 Dearborn St., Chicago. 25-4t

WANTED—POSITION with contractor, construction or manufacturing company, by young man 25 years, college education, 2 years mechanical and 1 year mining engineering. Experience, 2½ years special apprentice with railroad, 1 year inspector steel railway material, 1 year charge of power plant and construction. Can run instrument. Moderate salary, experience object, locate anywhere. William McCleary, School Lane, Germantown, Phila. 25-2t

WANTED—POSITION on construction or other work with either railroad, manufacturing or construction company by graduate civil engineer. Four years experience on various construction work two years as assistant engineer in direct charge of heavy railroad construction. Can furnish best of recommendations and A-No.-1 references. Graduate of one of best engineering colleges in this country. Now employed, but desire to better my position. No promoting schemes or drafting jobs will be considered. Address Box 75, care of Engineering-Contracting, 355 Dearborn St., Chicago, Ill. 25-3t

WANTS

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WANTED — POSITION — By experienced chain and rodman. I. C. S. surveyor graduate. Address "Grad.," 23 Back St., Cincinnati, O.

WANTED POSITION—Graduate engineer, over three years' experience on road, railway, municipal and mine surveys and construction; also five years' business experience; hard worker. H. B. Pope, Brooks, Ky. 24-4t

WANTED—POSITION—Civil engineer, European graduate, 17 years' experience in this country; expert bridge designer; all classes of structural work, reinforced concrete, etc.; good all round designer and estimator. Address "Designer," care of Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED POSITION—Graduate civil engineer, six years' experience on railway location and construction, drainage and municipal work; desires position as instrument man, draftsman or assistant engineer. Write for references. Address Box 72, Engineering-Contracting, 355 Dearborn St., Chicago. 24-4t

WANTED—POSITION—Stanford University graduate in mining engineering, five years' experience in railroad work, maintenance, location and construction, two years' placer mining in the Klondike, desires position as instrumentman in railroad or mining work. Address Box 63, care of Engineering-Contracting, 355 Dearborn St., Chicago, Ill.

WANTED—Civil engineer and surveyor, office and business in suburbs of Chicago, wishes to associate with Chicago engineer who requires an assistant; technical graduate; experienced in municipal work, street paving, sewer construction, land surveying, railway engineering and construction. Address Box 71, care of Engineering-Contracting, 355 Dearborn St., Chicago. 23-4teow

WANTED—POSITION—Contractor's superintendent; experienced on large contracts, dry docks, locks and dams canal work, power houses, reservoirs, difficult foundations, cofferdams, concrete piles, quicksand work, heavy masonry, earth and rock excavation, etc. Technical graduate. Present work just completed. Address Box 69, care of Engineering-Contracting, 355 Dearborn St., Chicago. 23-4t

SITUATION WANTED—Young civil engineer, open for engagement Dec. 1. College education. Eight years' experience as engineer and contractors' superintendent on bridges and buildings; particularly reinforced concrete construction. Also office experience. Single. Will go anywhere. Salary no object to start. Best references. Address Box 68, care of Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—POSITION—Civil engineer, 26; university graduate; experienced in field and office work. Prefer position as draftsman in reinforced concrete or bridge design. Have completed courses in mechanics, strength of materials, masonry construction, roofs and bridges. Now employed at \$90 per month. Wish better location. Address Box 67, care of Engineering-Contracting, 355 Dearborn St., Chicago. 23-3t

WANTED — POSITION — Mechanical and structural engineer wishes to change Jan. 1. At present assistant engineer for company manufacturing unit concrete reinforcement. Graduate M. E., with wide experience in heavy machinery, copper and lead smelting, mill and factory buildings in both steel and concrete. Chicago preferred, but will go elsewhere. Address Box 70, care of Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—POSITION—Superintendent with ten years' practical experience in charge of construction, railroads, power plants, barge canal, foundations, pile and sheet driving, heavy concrete construction, rock and quarry work, up-to-date stone crushing, concrete mixing, steam shovel and derrick plants, open for engagement Jan. 1, 1909. First-class references from present employers. New York or Pennsylvania preferred. Age 32. Address Box 73, care of Engineering-Contracting, 355 Dearborn St., Chicago. 24-2t

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Reinforced Concrete Design; Concrete Construction and Contracting.

CIRCULAR EXPLAINS

CONCRETE ENGINEERING

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Always state your special qualifications for each place.

ARCHITECTURAL DRAFTSMAN—Chicago. Thoroughly competent man for designing and detailing factory buildings, elevations, cross sections, floor plans, etc. Must be an American. Salary about \$25 per week. W-9205, The Engineering Agency, Inc., Chicago.

HYDRO-ELECTRIC OFFICE ENGINEER—West. Thoroughly competent man. Must be an American with several years' experience on Hydro-Electric work. \$150 to \$200. W-9205, The Engineering Agency, Inc., Chicago.

ORNAMENTAL IRON DRAFTSMAN—Tennessee. Young man with some experience in this line of work who could report quickly for position at \$85 per month. W-9242, The Engineering Agency, Inc., Chicago.

ARCHITECTURAL DRAFTSMAN—Iowa. Considerable experience. Capable of laying out plans and elevations from sketches and figuring them. \$30 to \$35 per week. W-9196, The Engineering Agency, Inc., Chicago.

ARCHITECTURAL DRAFTSMAN—Georgia. With previous experience on railroad buildings and structures, with a thorough knowledge of construction details, wood, brick and reinforced concrete buildings. Position permanent. Man needed quickly. Salary \$90 to \$125. W-9189, The Engineering Agency, Inc., Chicago.

INSTRUCTOR—New York. College wants a man to take charge of chemistry, physics and mathematics. Must be a good disciplinarian and understand the subjects thoroughly. Salary \$75 to \$100 per month. W-9172, The Engineering Agency, Inc., Chicago.

RAILROAD DRAFTSMAN—Mississippi. Competent young man for chief engineer's office. Maps, profiles, changes of line, estimates, etc. Salary \$60 per month. No transportation allowed. W-9182, The Engineering Agency, Inc., Chicago.

STONE QUARRY SUPERINTENDENT—For large cement company in Indiana. Must be competent to take charge of drilling, blasting and haulage of rock and shale from quarry to plant. Daily output 1,500 tons. Salary \$2,000 to \$2,500. W-9159, The Engineering Agency, Inc., Chicago.

ORNAMENTAL IRON DRAFTSMAN—Seven. Minnesota, Illinois, Chicago, Indiana, San Francisco. \$35 to \$125. W-9147, The Engineering Agency, Inc., Chicago.

PROFESSOR ELECTRICAL ENGINEERING—West. \$2,000. M-8730, The Engineering Agency, Inc., Chicago.

INSTRUCTOR MECHANICAL DRAWING—Central. \$70 to \$80. M-9203, The Engineering Agency, Inc., Chicago.

MECHANICAL DRAFTSMAN—Central. Combination mechanical and structural work. \$90 to \$100. M-9194, The Engineering Agency, Inc., Chicago.

MECHANICAL DRAFTSMAN—Collins engines. East. \$89 to \$115. M-9200, The Engineering Agency, Inc., Chicago.

MECHANICAL DRAFTSMAN—Central. For bridge machinery, including electrical work. M-9204, The Engineering Agency, Inc., Chicago.

SUPERINTENDENT WATER WORKS—East. Salary \$1,000. M-9149, The Engineering Agency, Inc., Chicago.

Above positions can be applied for by members only. Annual fee \$2.00. Non-members' correspondence solicited.

The Engineering Agency, Inc.

Monadnock Block, CHICAGO

Established 1893

For Sale Cheap

Second Hand **EXCAVATOR** Kearn's Pattern
formerly used by U. S. Government.

Also two 12-ton 36-inch gauge
and one 15-ton 36-inch gauge

Saddle Tank Locomotives

Also
Relaying Rails
all weights

BLOCK-POLLAK IRON CO.

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FOR SALE

A two-yard Bucyrus

DIPPER DREDGE

in good repair.

Hoisting Engines 10x14; Swinging Engines 8x10, 82-foot boom; new 46-foot dipper arm; 90-horse power boiler; electric light plant, tools, etc. Apply to

AARON POLLARD,
CHANDLERVILLE, ILLINOIS.

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An Investigation Should Be Made of the Blackwell's Island and Manhattan Bridges.

In our issue of Nov. 25, and again on Dec. 9, in commenting on the Blackwell's Island bridge erected by the city of New York over the East river, **ENGINEERING-CONTRACTING** asked that a board of expert bridge engineers be appointed by the city to report on the bridge to other than the Bridge Department. This board should make a thorough investigation of the contract and specifications, the stress sheets and drawings, the methods used in calculating the stresses and, in fact, all details regarding the bridge. We are satisfied that the revelations regarding this bridge will be as startling as those made by the board of engineers investigating the Quebec bridge.

On Dec. 9, we asked that this investigating board be required also to report on the Manhattan bridge, a suspension bridge now being erected over East River, so that if anything is wrong with this structure, it can be remedied at once, before it is too late to make radical changes.

For this bridge the towers and anchors have been completed and the main cables are being placed, while work is being done on the approaches.

At about the same date of our editorial, the City Club of New York wrote a letter to the mayor of the city asking that a report be made on the Manhattan bridge. In response to these two demands the Bridge Department has appointed Mr. Ralph Modjeski of Chicago to make a report to this department on the Manhattan bridge.

This eminent bridge engineer is, we believe, fitted to make such a report, but the Bridge Department is thus undertaking to investigate itself, which is a procedure that may or may not lead to the sort of an investigation that is really needed.

In our issue of Dec. 9 we published two papers on the Blackwell's Island bridge, delivered before the Technical League of New York. In this issue we publish a third paper read before the league. These papers showed that there were points of controversy on the loading of such mammoth bridges, and in one paper the startling statement was made that on the original stress sheets on which the contract was let, that there was "not a single stress correctly calculated."

Such conditions as these call for more than a report; they demand an investigation. We have already stated that, when an engineer is engaged to make a report, professional etiquette limits him to confine his report to the points he is asked to examine, and not criticise or find fault with those who are employing him. An investigating committee will not be hampered in this manner, especially if it reports to some department of the city other than the Bridge Department.

We again urge that such a board of

engineers be appointed at once, and we recommend that its report be made to the Board of Estimate and Apportionment.

License Laws for Engineers and Surveyors.

A correspondent in this issue urges our aid in furthering a license law for surveyors and engineers. We appreciate to the utmost we think the feelings of this correspondent and of hundreds of other engineers in similar case, who have to compete with the incompetent and the rascal in engineering work. We have had to meet such competition ourselves and our recollections of those occasions are not kindly. Will it correct the trouble to make engineering (including surveying), a close profession? It will to a considerable extent, probably, so far as surveying is concerned, but we cannot convince ourselves that any material advantage will be gained from a license law for engineers. In making this assertion, we realize that many engineers of high standing hold the opposite opinion, and we are not beyond being convinced that our opinion is erroneous. In any event, the question is worthy of discussion, and as a possible spur to such discussion, we shall here present very briefly, the reasons for the belief that is in us.

There is no American experience either proving or disproving the value of a law licensing engineers and surveyors. So far as we know there is only one state (Louisiana) that has such a law. As this law is only a few months old, its results cannot yet be told. That they will be anything but fruitless we do not believe, for reasons which we stated editorially in our issue of July 29, 1908. We shall refer to this law again in another regard, but for the present we need only say that it counts for nothing either for or against the efficacy of license laws in remedying the faults of which our correspondent voices a general complaint. Precedent not being available for our guidance, we must approach the problem along the way of general knowledge and logic.

The professional incompetent and rascal are found in the engineering profession—there is no profession in which they do not exist. To eliminate them would be a most desirable thing. It has for a long time been proposed to do so by legislation of the nature of a license law. The advocacy of such laws has been based on two principal contentions: (1) The competent, honest engineer and surveyor should be rid from the business competition of the incompetent and the rascal and the engineering profession should be freed from the stigma of their faulty and fraudulent work; (2) The public should be protected from the waste of money and danger to life, due to defective and inadequate engineering constructions. How will a law restricting the practice of engineering—a license law—work to effect either of these objects?

Let us first consider object, number one. There are, we believe, very narrow limits to the restrictions which any state legislature will place on the free practice of engineering and surveying on the mere plea that the business of competent and honest practitioners is injured by possible other incompetent and rascally practitioners. The average legislator will not see why, what he regards as the business of engineering and surveying, should be protected more than other businesses from the ills which he regards as common to all. He is likely to regard the pleader for such protection as wishing unjustly to restrict competition. You may convince him to the contrary, but he will still be loth to set a barrier to the free right of any man to earn his living by any honest vocation which he desires to follow. He argues that the incompetent man will soon have his incompetency discovered and will not command employment, and that there are already courts and civil and criminal laws amply capable of curbing the rascal. The result will be, not that no license law can be passed, perhaps, but that the barriers of restriction in any such law will be so low that there might as well be an open field. The Louisiana license law is, to our mind, an example of just such a result.

The Louisiana law provides that any person practicing civil engineering or surveying within the state at the time of its enactment, could become a licensed surveyor or civil engineer by the mere act of registering as such a practitioner within ninety days. None of the incompetents or rascals, if such there were in the field, was "eliminated" by the law unless it was their own sweet will to be eliminated by failing to register. As for the future accessions to the profession, the law provides that they shall pass a satisfactory examination in:

"For Surveying: Geometry, trigonometry, land surveying, general use of instruments.

For Civil Engineering: Same as surveying, in addition thereto natural philosophy or physics."

We cannot believe that such a law embodied the restrictions that its engineer promoters wished or considered essential; it must represent only what they were able to get.

We appreciate that because of the fact that the Louisiana license law may be faulty, we cannot condemn all restrictive legislation. But can any license law be passed which will be effective in eradicating the evil conditions of which our correspondent speaks? Partially, it is probable, in so far as the practice of surveying is concerned. Examination will tell us pretty certainly whether a man is competent to make public surveys. We can thus shut out the honest incompetent. Examination cannot detect the man who may do rascally work, and this man is generally competent to pass any examination likely to be given him. We cannot see how any examination compre-

hensive and severe enough to determine whether an engineer is competent to design and construct can be devised and be safe from being over-ruled by the courts. Any lesser test will possibly shut out the ignoramus in engineering and surveying, but there is no certainty that it will shut out the rascal.

There is still another phase to this problem of devising restrictive legislation. We will assume that engineers generally hold such legislation to be desirable, which is by no means the fact. It is reasonable then to assume also that they would hold that it be universal. Shall we have a national law or shall each state have its separate law, and, if the latter be the case how shall we provide that an engineer licensed in one state may practice in another state? Then, shall we give every man, whatever his ability and experience, the same certificate or shall we grade him as first, second or third class? These questions do not exhaust the possibilities in this direction, but they will suffice to indicate the intricacies of the problem.

We have pointed out why in our opinion any plea to our lawmakers for legislation restricting the practice of engineering and surveying will, if based alone on the claim of ignorant or dishonest competition, bring abortive results if it brings any results. When, however, we come to the second of the above stated objects of such legislation, we have a legitimate claim for consideration—one that we can get our legislators to listen to. If any legislation restrictive or otherwise, that is of any real value is to be obtained, it must be got on the plea of public safety and welfare. No call by any class of professional workers for special protection in their work from the ignorant and dishonest numbers of their own body will be listened to. A call for the protection of the public purse and the safety and health of the people will be listened to. This last then is the main argument which engineers must advance for limiting by law the damage which the incompetents, charlatans and rascals wearing the cloak of the profession can do and are doing.

Taking this ground it is not, as we can see, so much the fact that engineering incompetents and rascals exist that is dangerous, as it is the fact that the public must suffer in purse and safety because of the deficient and dishonest constructions of such persons. Does this not suggest that it might be wiser to subject to inquiry the engineer's work rather than the engineer himself? It seems to us that it does. Then why should each state not have a board or commission of competent engineers to whom all plans for engineering work involving to any degree, the matters of public welfare and safety of health or life, must be submitted for approval? We have good precedents for such regulation. Only this year (ENGINEERING-CONTRACTING, May 6, 1908), the state of Ohio enacted a law placing all works for sewage disposal and water purification under the supervision of

the State Board of Health. The construction of new works and the operation of old works must satisfy the engineers and sanitarians of the Board of their engineering practicability, good design and construction and efficiency. Other states have similar laws. In England for years all engineering works of public character have been subject to approval in design, construction, etc., by the Local Government Board. The Building Departments of our large cities are well known examples of the same type of regulation. We have recently pointed out that had the city of New York possessed an independent board of reviewing engineers, it is improbable that its officials would have had an Ashokan Reservoir controversy or a Blackwell's Island Bridge scandal to digest.

It will be argued that while such regulatory legislation as is suggested may cover the proper design and construction of the more important engineering works, it does not shut out the ignoramus from the county surveyor's office or prevent last year's rodman from hanging out this year a "Civil Engineer and Surveyor" sign board. Here truly is a difficulty, and so far as we can see now it has to be overcome by other means. Our correspondent suggests that county surveyors be put on a salary and be appointed after examination instead of being elected. We are inclined to endorse this suggestion. We believe that as a general principle a political appointment to an engineering office is more certain to be good than is a political election to an engineering office. With respect to the license law suggested for engineers and surveyors in private practice we have expressed our ideas quite fully in the preceding paragraphs.

The new Scherzer rolling lift bridge across the Ngawun River in Burma, India, has been completed and opened for railroad traffic. This, the largest bridge constructed in Burma, has a movable span 220 ft. long, the total length of bridge being 820 ft. The bridge is constructed on the main line of the Burma Railway's extension connecting Rangoon with Kyngin. The bridge was designed by the Scherzer Rolling Lift Bridge Co. of Chicago and New York and manufactured in England at the works of Spencer & Co., Melksham, Wilts, and erected in Burma under the charge of the engineers of the Scherzer Rolling Lift Bridge Co. Though the difficulties to contend with were very great the bridge was completed within a year. During the rainy season, extending from May to October, the river was subject to great floods. During the dry season several hundred natives died from an epidemic of Asiatic cholera.

In 1907 the production of silver in Mexico was valued at \$35,515,000; the gold production for the same period was valued at \$17,793,000.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Construction Details of Reinforced Concrete Work.*

By DE FOREST H. DIXON.†

The safety of any piece of engineering work is dependent, primarily, upon its correct general design, and by correct general design is here meant that the loads to be carried by the structure are properly computed, and that the beams, columns, and other portions of the structure are then figured in accordance with such loads, allowing a proper factor of safety to cover defects in construction and possible over-loading. Perhaps all of us present have been impressed by the very uncertain behavior of reinforced concrete floors, as described in recent numbers of our engineering press. On one page we read a description of a test on some floor, which test shows a load of three times the assumed live load, carried on spans of 16 ft., with a deflection of about $\frac{1}{8}$ in. Turning over a few pages, our eye is met by photographs which might be supposed to represent the devastation caused by earthquake shocks, were it not that the accompanying text informs us that they show the result of removing the forms from under one of the upper floors of some building, after the concrete forming such floor had been in place three or four weeks. We are informed that the floor in question fell under its own weight, and that, in falling, it carried much below with it. On reading such a description, the natural opinion formed is that exceedingly poor materials were used or careless work was done, and such an opinion is only too often justified by the facts; but the speaker, knowing how much abuse reinforced concrete will stand without failing, is impelled to inquire if possibly there are not other causes partially responsible for these failures, in addition to poor materials and bad work. Such inquiry leads him to the belief that, in many cases, either through ignorance or desire to do cheap work, the factor of safety used in design, is so juggled as to be greatly diminished, thus inviting disaster. With a factor of safety partly done away with, before the actual work of construction is begun, it is evident that poor workmanship, which, with a proper safety factor, would pass unnoticed, will lead to failure. That the condition stated is not imaginary by any means,

may be shown by quoting from a letter recently published in which an engineer explains the partial failure of some roof beams designed by him, as follows:

"The building was originally designed to be of 12-in. brick walls, flimsy iron trusses, and corrugated iron roof, and the owner made a demand upon me to design a building to come within the price of the above construction, and I, therefore, assumed a factor of safety of about 2, in the construction, temperature stresses being considered."

Now, I do not know how often an examination of floors that have failed, would reveal a factor of safety of about 2, used in design; but it is my belief that such would be the case more often than might be supposed. I do know that a floor is sometimes said to be figured with a factor of safety of 4, when it is designed to fail under its dead load plus 4 times the assumed live load, instead of under 4 times the sum of its live and dead loads, as should be understood when factor of safety of four is given. How great the difference is between these two definitions of factor of safety, can be shown by taking a floor designed for a live load of 75 lbs. per sq. ft. This floor will probably weigh about 75 lbs. per sq. ft., which is the dead load. Using one definition of factor of safety, and assuming said safety factor to be 4, this floor would be designed to fail under a total load of 375 lbs. per sq. ft. Under the other definition, it would be designed to carry a total load of 600 lbs. per sq. ft.

The author has heard of various other liberties having been taken with the factor of safety, and he feels that the time has about come when we must ask that concrete construction be given a fair chance, for it certainly is not getting it now, and the first step in that direction is going to be to get those in charge of buildings to assure themselves that the design is correct and ample. Perhaps I have dwelt upon this point of skimping the design at too great length, as here, in New York, the tendency to skimp is not apparent, owing to the existence of a vigilant building department, which, if I may be pardoned for saying so, leans toward the side of too heavy, rather than too light design, and leans pretty hard at that. But what has been said helps in part to explain a good many failures. I say in part, because the immediate and most prominent cause is almost invariably poor

material or poor workmanship. These defects it is our intention to discuss at some length, but before doing so you must pardon a few words on the question of plans, for, unless proper plans are furnished to the superintendent in charge of the work, his attention, instead of being concentrated on the securing of the best and most economical ways of handling his work, will be necessarily diverted. He will have to supply such data as his plans lack. In some quarters there appears to be the impression that very meager plans will serve for reinforced concrete work. This is not the case, and, as a matter of fact, the drawings required for a reinforced concrete building are almost as extensive as those required for a building carried by structural steel. The importance of such aid, as complete plans and correctly prepared schedules of steel bars, windows, doors, etc., give towards the securing of good, rapid and economical work, cannot be overestimated.

Assuming now, that our superintendent in charge of the work has been furnished with such detailed plans as we have described, let us examine the questions which confront him in his efforts to secure, in the structure, the full strength possible, under the plans given him. It is to be noted first that he himself should necessarily understand the intent and purpose of the design in order that he may effectively execute the same, or, in other words, that he be able to appreciate the fact that, if the floor slab is figured as part of the compression member of a beam, he is required to place the beam and slab at one time, or, if, for any reason, this is impossible, then he must provide sufficient steel bonding between the beam and the slab to take up the horizontal shear. Many other questions arise that require engineering judgment, and while exceptions may in extreme cases be made, it is certainly advisable that the superintendent in charge of any piece of reinforced concrete work be an engineer; or that, if the superintendent be not an engineer, that one of his assistants shall have had such training. As to the character of the men comprising the organization at the command of our superintendent, it is also desirable that the steel foreman be a graduate of an engineering school. This is desirable, not only because he will then appreciate the reason for the work which is under his control, but also because his education fits him to readily read complicated plans and schedules. A company will find one of its best training schools for future superintendents in the position of steel foremen. The concrete foreman must be a thoroughly trustworthy man, and one who will do as he is told even though he may consider the instructions given him as foolish and unnecessary. The foreman who applies for a position, and couples with his application a statement that he has been engaged in fire-

*A paper read before the Municipal Engineers of the City of New York, Feb. 27, 1907.
†General Superintendent, Turner Construction Co., New York City.

profiting and sidewalk work for the past 15 years, and hence knows concrete from A to Z, is usually though not always, a poor man to select, for the reason that he has been putting in concrete under conditions where a poor mixture has answered all visible and immediate requirements, and he has it firmly imbedded in his mind that the grade of work he has been turning out is sufficiently good, and, that when a better grade of work is insisted upon, it is because of the whim of the man making such demand. To use an old phrase, "It is hard to teach an old dog new tricks." These remarks upon the subject of organization have been made because the speaker believes that the attempt to rapidly carry on large constructions in reinforced concrete, with an organization not thoroughly trained and possessing engineering judgment, invites failure.

Taking up now various points that require attention on the building, we come, first, to the question of the proper inspection of the materials used.

INSPECTION OF MATERIAL.

The most important materials used are cement, sand, gravel or stone, and steel. As to all but the latter, New York occupies an almost unique position, and it is doubtful if any other place in the country is so favored as regards the material required to make good concrete. Long Island is one inexhaustible sand and gravel bank of the best quality, while the Hudson gives us trap which is perfection itself. Owing to an extensive waterfront, these materials can nearly always be delivered on scows near the work. How fortunate we are in this respect cannot be appreciated, until one has seen the quality of sand and stone used in other less fortunate regions, and often used willingly, because the inhabitants of those regions have never seen anything better.

Cement, if of an old and established brand, is very unlikely to be poor, but, on extensive work, arrangements may be made to have the cement tested at the mill before shipment. Reliable testing laboratories having offices in the mill district will sample cars as loaded, seal them, and then forward the results of soundness and 7-day tests by mail, so that they will arrive on the job before the cement is received.

Sand.—It is very important that the sand be clean and sharp. Place little confidence in statements published not long since, in the engineering press, to the effect that clay, to a very considerable extent, does not injure sand. Note that the clay used in these tests was ground as a dry powder, and then mixed with the sand. In nature, clay occurs as a slimy lubricant, and even a comparatively small amount of it will have a marked effect, especially upon the time required for the concrete to set and gain even partial strength. If the sand is to come from a local bank, make sure that the bank is

properly stripped, or, better yet, have the sand delivered ahead, and inspect it before using. Finally, if there is any question as to its fitness, have it tested, in a one-to-three mixture. The cost of doing this is small, but the information obtained is valuable.

Gravel.—Good gravel gives equal strength with stone for use in beams and floor slabs. It makes a concrete easy to work into difficult positions, and is to be preferred for many kinds of work. As with sand, examine gravel carefully to make sure that it is not covered with a slime of clay.

Broken Stone.—The commercial $\frac{3}{4}$ -in. size is best suited for most reinforced work. Clean stone dust is not injurious, if its presence is taken into account in proportioning the amount of sand used; but watch for the presence of dirt instead of dust, as considerable dirt may sometimes be present if the quarry from which the stone comes has a seamy formation.

Steel.—The inspection of the steel used is, perhaps, of more importance than might at first be assumed, for the impression prevails that steel, as manufactured at the present time, is a uniform product, and experience confirms this impression in so far as the product of some mills is concerned, but the product of those small mills that roll from old rails and scrap requires very careful inspection. This is especially true if a high carbon steel is employed.

As to the use of plain bars, or so-called mechanical bond bars, the author is strongly in favor of using bars possessing a mechanical bond. Aside from the usual reasons given for this preference, with which all are probably familiar, he believes that, with a plain bar, there is a very real danger—that the bond between the concrete and the steel will be broken either by wheeling over the floor before the concrete has gained its strength, or by the removal of the forms from under a floor before the concrete has attained its full strength. As a practical point, he doubts very much if plain bars left projecting from one body of concrete, for the purpose of bonding it to an adjoining portion of the structure, serve in full measure the purpose for which they are intended, because such projecting bars are often hit, thus loosening their hold on the concrete.

FORMS.

We are interested in this part of the work because of the fact that the success or failure of a job, as a money making proposition, is largely dependent upon the way in which the form work is handled. Speaking roughly, the labor item on the forms required for a floor, is greater than the cost item for all the concrete, steel and finish labor, required to complete the floor. In the form work, the lumber item, while large, is overshadowed by the labor charge. In the items of concrete, steel and finish, the cost of ma-

terial is the predominating factor. It is seldom that serious errors are made in estimating the cost of material. Far more often, if there be an error, it is in estimating the labor item, and as the carpenter labor on an entire building just about equals all the rest of the labor required on that building, it is evident that a designer, having a proper knowledge of this condition, will use every care so to design his work, as to reduce the labor item on forms to a minimum. He will keep constantly before his mind the fact that economy in form work is obtained by the repeated use of the same panel or mold; hence he will do some careful figuring before making the beam lay-out on different floors dissimilar—even though, at first thought, a saving may seem to be effected by so doing. In the designing of ornamental details, it is desirable to repeat the same form wherever possible. If the forms are to be made of wood, warped surfaces must, of course, be avoided. In constructing belt courses, and other ornamental details, it is usually best to omit these features at the time of carrying out the main structure; providing, however, recesses and bond bars in the proper places. Doing this makes it possible to build belt courses, corbels, etc., later at a convenient season, yet without interfering with the time of the completion of the building, and admits of using one form which is moved from one point to another. The subject of form work is complicated by so many considerations that no attempt will be made here to go into further details, except to call attention to the additional cost which is occasioned by so designing the front of a building as to require the wall construction to be carried past the floor level, as a monolith, or in other words, by failing to provide a break of some kind in the construction at the floor levels.

Of course, the author understands that, oftentimes, the architectural effect must outweigh matters of cost, and has no intention of advancing this point as a criticism of work that has been done.

PLACING STEEL REINFORCEMENT.

The aim to be attained under this heading, is that the steel reinforcement shall be placed as shown on the plans, and, further, that it shall be so placed as to remain in its proper position during concreting. As the steel is entirely imbedded in the concrete, there is no means of knowing, after the concrete is once in place, whether the steel is in proper position or not—hence, it becomes important to carefully inspect all steel in place before concreting is begun. To admit of this inspection, steel for a day's work should be placed in advance of the concrete. It then becomes an easy matter for the superintendent to look it over and make sure that it is in place as required. Your attention is called to the large gain in strength secured by bending up beam bars at their ends. A beam having its steel reinforce-

ment so bent up, is about 40 per cent stronger than one having the same amount of steel placed in the bottom of the beam throughout its length. This gain of 40 per cent is entirely independent of continuous action, for the experiments upon which this percentage is based were made upon test beams which were entirely free at their ends. The reason for this increase in strength, even with free ends, is probably due, in part, to the strengthening of the beam near its ends, against diagonal tension; but the truss action of the bent rods probably also plays an important part.

In designing reinforcements, it is important that two bodies cannot occupy the same space, at the same time. This fact would seem self-evident, but the speaker has seen a great deal of trouble and expense caused by the designer laying out his reinforcement so that bars in the beams, girders and columns, would interfere, thus making it difficult to place the steel in the best manner. The requirement of the New York Department that beams be designed as free ended, should not prevent care being taken to secure the advantages of continuous action, by lapping girder and beam steel at the ends. Where new portions of a building are to be connected to parts already in place, care should be taken while building the first portion to have bond bars projecting. It is to be constantly kept in mind that one of the chief and unique elements of strength, in reinforced concrete, is its monolithic character, and while it is impossible, and, also, inadvisable, to place all the concrete in a large structure at one time, it should be our constant aim to so place our steel as to maintain, as far as possible, the monolithic character of the work.

Columns are now almost universally reinforced with spiral hooping. In addition to this spiral reinforcement, vertical rods connected by threaded couplings should be used in the columns of buildings which are to be subjected to heavy vibration. In designing column reinforcement, care must be taken to avoid such an arrangement of the steel as will make it difficult to work the concrete thoroughly into place. With the use of spiral reinforcement and vertical rods, as described, no trouble need be apprehended, because the entire column is open, and the concrete may be thoroughly spaded. The author has heard of one case where a complicated system of column reinforcement was used, involving a number of ties between the vertical bars. The result of thus obstructing the interior of the column was that, upon removing the forms from one column, it was found that the concrete, perhaps being a little too dry, had arched and that the column contained a cavity nearly large enough to accommodate a good sized boy. The statement is often made—"The detail is all right—the trouble is with its careless execution." This is very true, but what I am trying to impress

upon you is the importance of making details simple and practicable, and then insisting that they be carried out.

PLACING CONCRETE.

The concrete for reinforced work should always be what is known as a "wet mix." Under no circumstances, should a dry mix be allowed, as with too little water it is impossible to properly work the concrete around the reinforcement, and there is the gravest danger that the concrete will arch over points where the steel reinforcement forms a network, as, for example, where the beam and girder steel comes together over a column. The author considers that the best way to determine whether or not the concrete is wet enough, is to watch the filling of the beams. When dumped into a beam, the consistency should be such that, upon tapping the bottom of the beam form or the steel reinforcement, in advance of the concrete, the concrete will flow along the beam assuming an angle of about 10 to 15 degrees, with the horizontal. It is, perhaps, not desirable that it be so wet that the water will separate from the concrete to any extent, and flow in advance of the concrete, but it is always better to have too much rather than too little water. In placing concrete, jar the metal reinforcement in advance of the concrete, as this jarring assures the proper coating of the bar with mortar.

Next to the wetness of mix, neatness should be insisted upon. Every day's work should be boxed in, and the end of a day's work should be against vertical stoppers of wood placed in the middle of the beams, and across the slab. These stoppers have holes bored in them, through which the reinforcing rods project. In the author's opinion, the use of such stoppers, while adding somewhat to the expense, is very essential. The sloping off of concrete in the beams and girders should never be allowed. It is a well known fact that there is almost no bond between old and new concrete. This being the case, it is evident that, to leave a long fin of concrete in the bottom of a beam, at the end of a day's work, is inviting this fin to scale off within a very few minutes of the time when a fire hits it.

With a wet mix, concrete is its own best inspector, for when the forms are removed, any carelessness is at once apparent. If rough spots occur, they should be at once pointed out to the concrete foreman, and he, in time, should come to feel that, having his work show up rough, is little less than a crime.

The bottom of column forms should be carefully inspected before the concrete is placed, to make sure that all dirt has been removed. To facilitate this inspection, a portion of the column form on one side, and at the bottom, should be made separate, and one man should be given the duty of cleaning the column and replacing this movable portion of the form immediately before concreting. In filling

basement columns, it is, of course, necessary that ground water be kept below the top of the footing at the time concrete is placed, for, if the concrete be dumped into even a few inches of water, the cement will separate out, and the lower couple of feet of the column will consist of gravel and sand alone.

In concreting walls, the end of every day's work should be made to come at some break in the surface, as at the side of a pilaster. If the wall is without projections, then the jointing should be marked with a V-shaped strip, both horizontally and vertically. If this is impossible, which is seldom the case, then the juncture between old and new work should be made a perfectly straight line. If the surface is to be tooled, every separate area must be monolithic. This is a point often overlooked. Steel reinforcement should be placed around all openings to prevent the tendency to crack at the corners, and the juncture between a light and heavy section must be reinforced with steel well distributed.

GRANOLITHIC FINISH.

Granolithic finish should be placed monolithic with the slab, or, if placed afterwards, which is desirable in stables and some other class of work, its thickness should never be less than 1½ ins. Recently, an acid solution has been placed on the market which the author has tried in several instances, using, in some cases, finish as thin as ½ in., put on concrete that had attained an age of several months. This finish has been in place for three months, and thus far shows a perfect bond. If further tests confirm these conclusions, then one cause of worry in our work is partially removed, for the sudden thunderstorm, at three in the afternoon, will lose part of its terror.

In closing the author wishes to call attention to the easy attainment of the points he has outlined:

(1.) Good and complete plans.

(2.) Good organization—a matter of time, it is true; but coming to the final analysis of the cause of failures in reinforced concrete, we often find a new company trying to do too much work at the start, unmindful of the fact that it takes time to train men to properly perform new duties, and that to send an untried man hundreds of miles from home, to assume charge of work about which he really knows nothing, is not only inviting, but almost compelling failure.

(3.) Good materials—and it is easy to avoid mistakes here, if it is remembered that tests on such materials are not made merely for the purpose of recording them in big books on learned subjects.

(4.) Steel held in its proper position—and the placing of steel reinforcement before the concreting of a day's work is begun, makes this matter easy.

(5.) Good concrete—and a wet mix and

monitions work are here about all that are required to insure the result.

All of these factors are surely easy of achievement, and almost any one, or even two, of them, may be considerably neglected, and still the result will not be bad enough to weaken the construction to any serious extent. Please do not draw the conclusion that the purpose of my remarks has been to show how difficult it is to obtain good steel concrete work. My aim has been, rather, to point out how easy it is to do good work, and do it cheaply, for, with a proper plant and organization, good work is just as cheap as poor. The vicissitudes through which reinforced concrete is passing, are, no doubt, to be expected when its rapid expansion is considered, but the accounts of recent failures have made sad reading for the author, and he hopes that, before long, the public will awaken to the fact that reinforced concrete construction is a business requiring experience and will insist that it be handled with some regard to the elementary principles of mechanics and common sense.

The total excavation on the Isthmian Canal for November was 2,920,494 cu. yds. Of this 1,567,955 cu. yds. was dry excavation, 1,282,311 cu. yds. was wet excavation and 70,228 cu. yds. was outside the canal prism.

The street cleaning department of Magdeburg, Germany, has been making successful experiments with a sand-strewing wagon, for spreading sand on slippery streets. The wagon spreads rapidly an even layer of sand on the streets. This has heretofore been done in German cities exclusively by hand. The apparatus is worked by the driver and can be adjusted to strew a layer of sand or gravel from 19.68 to 52.49 ft. wide.

Rapid construction of concrete building walls has been recorded in the erection of the Leitel Iron Works of Grand Rapids, Mich. The walls were for the foundation of a building 84x100 ft. in plan and they were 4 ft. thick at the bottom, 2 ft. thick at the top and 18 ft. high. There were approximately 700 cu. yds. of concrete in the walls. Quality A-1 hemlock planks 2x12 ins. x 16 ft., with Sullivan plank-holders, were used. The forms were built only two planks high, as the weather was warm and the concrete set reasonably fast. The form materials required were 3,000 ft. B. M. of plank, 400 style A plank holders, 50 right and left plank holders, 65 lbs. No. 13 soft wire and 12 lbs. of 3/4-in. staples for ties. There was no studding or other bracing employed. The plank holders were all saved after the work and have been used several times since. The walls were built by the J. H. Sullivan Mfg. Co., Grand Rapids, Mich.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Method and Cost of Subaqueous Rock Excavation Using a Lobnitz Rock Breaker at Blyth Harbor England.

The construction and operation of the Lobnitz rock breaker for subaqueous rock excavation were described in our issue of Dec. 18, 1907, and the use of the machine at Black Rock Harbor near Buffalo, N. Y., was noted. Incidentally the economy of this method of subaqueous work at Blyth, England, was mentioned. More complete data of this English work are now available in a paper by Mr. George D. McGlashan in the proceedings of the Institute of Civil Engineers. Since the Lobnitz cutter has been introduced into America on the work mentioned above and is planned for use at Panama the following account of the work at Blyth Harbor will be of interest. The data was abstracted from Mr. McGlashan's paper:

In 1906 the Blyth Harbor Commissioners decided to carry out an extensive scheme of improvement, and among the works embraced in the scheme was the deepening of the harbor to 24 ft. at low water of spring tides, involving the removal of about 500,000 cu. yds. of rock. For this purpose it was decided to employ a Lobnitz patent rock breaker, and so successful were the results that a second machine was obtained this year (1907).

This method of rock breaking consists in the repeated blows of a long, heavy pointed chisel or ram, which falls by its own weight upon the rock to be broken. No explosives are required. The machine consists of a barge upon which stand the tripod legs supporting the ram, a winch for hoisting the ram by means of a wire rope led over a sheave at the top of the tripod, another winch for operating the chains that maneuver the barge, an ordinary marine boiler for supplying steam to the winches, and smaller supplementary machinery and plant.

Method of Operation.—To operate the rock breaker the barge is first brought over the site, the surface of the rock having previously been dredged clean, and there is securely moored in position by single fore and aft cables and side chains at each quarter—six chains in all. The ram is then gently lowered until the point rests upon the rock, and a gage, painted on the ram, indicates to the hoisting winchman the required height of lift, generally about 8 ft. When lifted, steam is partially shut off to prevent the winch engines racing, and the coil clutch is released to drop the ram. The

operation of raising and releasing the ram is continued until the rock is penetrated to the required depth. The barge is then moved to a spot 3 or 4 ft. away, and the ram allowed to penetrate the rock to the same depth as before, after which it is moved another 3 or 4 ft., and so on.

Each new position of the ram must be fixed with great care, and this is effected by two sighting poles on shore being kept in line with two sighting rods on board. The space between adjacent spots penetrated by the ram in one direction is called the "pitch," while the spacing in a direction at right angles is called the "advance." The pitch and advance are always made equal. The pitch first adopted at Blyth was 3 ft., but was increased to 3 ft. 6 ins., then to 4 ft., and ultimately to 4 ft. 6 ins. This latter pitch is now maintained throughout. The rock removed consisted, for the greater part, of the calcareous sandstone commonly found in the coal measures, portions of which were almost as hard as granite. The beds of sandstone alternated with thin layers of shale and sometimes of coal. The dredging results of the various pitches were carefully watched, but the only perceptible difference between the 3-ft. pitch and the 4-ft. 6-in. pitch was that with the latter the pieces of broken rock were larger than with the former, but there was no practical difference in the rate of dredging. Theoretically there ought to be an economical pitch and advance, according to the degree of hardness of the rock to be broken, and it is worth while ascertaining this pitch by experiment, if the character of rock is fairly uniform over large area, but where the rock is varied in character, it is advantageous, for practical reasons, to ascertain the best average pitch and advance and maintain them throughout. The total penetration is generally 3 ft.; with a greater penetration there is the risk of the ram occasionally sticking fast in the rock. The ram is generally made to fall 8 ft., and with this fall about four blows per minute can be delivered. The number of blows for a penetration of 3 ft. varied from 5 to 15, according to the hardness of the rock, but for fairly hard sandstone eight blows may be taken as an average. The pieces of rock broken with a 4-ft. 6-in. pitch average about 3/4 cu. ft., but occasionally there were pieces weighing about a ton. The rock is generally so well broken up that it can be dredged fully 15 per cent faster than blasted rock, and a uniform surface on the rock is obtained.

Experiments were made with the rock breaker on hard rock exposed at low water

and showed that the rock was completely pulverized on the spots where the ram fell, and for about a foot around each hole made by the ram the rock was broken into small pieces and forced up above the original surface; beyond this the rock was thoroughly fissured, and some of the pieces were forced up. The thorough breaking up of the rock is an advantage for dredging purposes, as compared with blasted rock. It frequently happens in blasting rock under water, when the strata is horizontal, that the rock surrounding the lower portion of the bore hole containing the shot is completely shattered, but the upper panels are only fissured, and not dislodged—due, probably in part to the overlying weight of water. The dredger has consequently considerable difficulty in "breaking into" this rock when commencing to dredge a new area; this difficulty does not occur when the rock breaker is used.

The rock breaker was originally fitted with two sighting frames, each having a vertical sliding bar, and allowing of a total advance of the barge of 13 ft. 6 ins. for each position of the poles on shore, but this advance was found to be insufficient owing to obstructions between the barge and the shore, and also to allow of spanning graving dock entrances, etc. A sighting frame was therefore erected along each side of the barge for nearly its full length, allowing of a total advance of about 80 ft. before the poles on shore need be moved. At night time the poles on shore are indicated by lamps. The poles are placed alongside pegs previously put in position and are at right angles to a base line, which is plotted upon a plan kept in the office, and upon which the progress of the rock breaker is recorded day by day. A graduated measuring wire, wound around a small drum on board, with one end fixed to the base line, gives the position of the barge. Some difficulty was experienced in preserving the correct positions of the barge when ships lay between it and the sighting poles; this difficulty was, in some measure, overcome by maintaining the bearing of the base line on a mariner's compass, and by careful manipulation of the maneuvering chains.

The wire rope used at Blyth for lifting the ram is 5 ins. in circumference and 167 ft. long, and is composed of six strands surrounding a hemp core. An eye is spliced at one end for attaching to the drum. This wire rope is subject to severe usage, and consequently its life is short, so that it is one of the chief items of maintenance. Should the winchman apply the friction clutch before the ram has struck the rock the wire rope is subject to a severe pull, and a severe stress is put upon the winch itself; should he, however, be late in applying the clutch the wire rope will spin off the drum and kick at the head of the ram, and also close to the drum. With practice men acquire considerable skill in operating the winch, but even when the application of the clutch is correctly timed a certain amount of slackening of the rope invari-

bly occurs, which sometimes forms a kink at the head of the ram. There are two places where the wire rope tends to fail, one near to the ram head where the kink occurs and the other at the drum, due to friction. Considerable friction, and consequent wear of the rope, also takes place at the sheave, which is 3 ft. in diameter, for at the moment the ram has struck the rock the rope is at a standstill, but the sheave continues to revolve by virtue of its kinetic energy. At Blyth, however, none of the wire ropes has had to be taken off on this account. To lessen the sharpness of the kink at the ram head the wire rope is laid with serving wire for a distance of 15 ft. from the ram head attachment, and a later improvement is to worm the rope with $\frac{3}{4}$ -in. soft iron wire before putting on the serving. There is great difficulty in getting wire rope of suitable quality, as it must be soft enough not to be affected by the kinking, hard enough to resist friction, and with a sufficient margin of safety for working. Experiments are at present being made at Blyth with various kinds of wire rope from different makers, but up to the present the longest life of a wire rope has been 495 actual working hours. At least two spare wire ropes are always kept on board ready for use.

In a harbor or waterway the shore fastenings for the mooring chains of the barge are an important matter, and if ordinary single or double fluked anchors are laid down in a harbor bottom they may be a source of danger to shipping. Based on the experience at Blyth the author's opinion is that the best system of land mooring for rock breakers, where quays are concerned and where a large amount of rock has to be removed, is to have chains attached permanently by a diver to the quay face, as low down as possible, and of sufficient length to be brought up to near the top of the quay, where the ends are temporarily fastened. The chains are spaced at convenient intervals along the quay, and are easily brought into use by shackling them to the ends of the rock breaker's chains. This affords a more expeditious and convenient system of mooring than that of a bridle chain along the quay. The initial cost of laying these chains will be more than compensated for by the saving in labor, and by the time that the rock breaker itself would probably otherwise be idle. These moorings can moreover be used by the dredgers.

The rock breakers at Blyth work on double shift, and are manned by two crews, each consisting of four men—the skipper, the hoisting winchman, the maneuvering winchman and the stoker. It has been found that seafaring men make the best skippers, but they must be active, intelligent, and with a fair education. It is an advantage if the hoisting winchman is somewhat of a mechanic, as he can then more readily understand the cause of and possibly remedy any trifling breakdown of the machinery. Each crew works a week

on day shift and a week on night shift alternately, making 11 shifts of 12 hours each per fortnight per man.

Cost Data.—The following are the full time weekly wages paid to crew:

Skipper	\$10.70
Hoisting winchman.....	9.70
Maneuvering	8.30
Stoker	8.30
	\$37.00

The coal-consumption averages 2.7 tons (of 2,000 lbs.) per 24 working hours. A large wooden tank carried on a barge is used to convey fresh water to the rock breakers. The level of the bottom of this tank being above the top of the tank in the rock breaker, no pumping is required. The consumption of water is about 17,000 gals. for a full working week. Salt water could be used, but for many reasons it is less economical.

Weather is a factor much affecting the cost, and in this connection the author has observed that the motion of the rock breaker due to 18-in. waves causes the ram in falling to strike the guide, thereby lessening the force of the blow, and necessitating a larger number of blows for a given penetration.

When rock has to be removed above low water level in tidal harbors, the time during which the rock breaker can work is limited by the height of the rock and by the range of the tide, and it is an advantage if there is rock to be broken in deeper water close by. It is safer only to work on high rock with a rising tide, for then should the wire rope suddenly fail, or come out of its attachment, the flotation of the barge may be used to lift the ram, and when the latter is clear of the ground, the barge can be hauled into a safe position. Serious damage might ensue to the barge if the wire rope failed when working on high ground on an ebb tide.

A systematic method of recording the results of the rock breaking is essential for economical working, and the author therefore adopted a system of "Daily Recording Sheets," compiled from the returns, from which the quantity of rock broken per day is obtained. These sheets give the following information: The number of the "ordinate" (an ordinate is a line followed by the rock breaker at right angles to the base line), the pitch, the advance from the last ordinate, the distance of the ram from the base line, the penetration of the rock for each series of blows, the number of blows for each position of the ram, etc. All delays and stoppages, with the reasons, were also recorded, together with the times of stopping and restarting work. In this way, the progress of the work could be closely followed, and any laxity in the working of the rock breaker immediately detected, as well as the stoppages arising from preventable causes.

It was ascertained at Blyth, by soundings taken both before the rock was broken and after the dredging, that when the

ram penetrated 3 ft. the rock could be dredged for a depth of 2 ft. 6 ins.

As rock breaker No. 2 was only put into operation recently, the following particulars refer to rock breaker No. 1:

The maximum quantity of rock broken in one week was 1,975 cu. yds. The total quantity broken over a period of 27 weeks, including holidays and other stoppages, was 24,535 cu. yds., giving 908 cu. yds. as the weekly average.

During the period of 27 weeks 229 shifts were worked, each of 12 hours, and since 24,535

eleven shifts constitute a full week, $\frac{229}{11} = 1,177$ cu. yds., is the average for a full working week.

The following is an analysis of the rock breaker's working time over the 27 weeks above referred to, derived from the daily record sheets:

	Per Cent.
Delays (including holidays) due to—	
Shifting moorings to new positions and picking up and shackling together mooring chains broken by ships	9.12
Traffic	3.18
Repairs, including changing of wire ropes and ram points.....	20.68
Weather and moving to new moorings and berthage at week ends...	5.75
Boiler cleaning, etc.....	6.54
Tide	1.28
Meals	7.75
Total delays.....	54.30
Actual time breaking rock.....	45.70

Total working time.....100.00
The total cost of breaking the rock is obtained as follows:

Details of working costs for 27 weeks—	
Wages of crew, towage, supervision and proportion of expense of water and coal conveyance	\$2,112.48
Coal (net cost).....	673.42
Water* (net cost).....	99.64
Stores	84.87
	\$2,970.41

Maintenance—	
Repairs, labor and material	\$ 360.30
Boiler cleaning.....	48.67
Five wire ropes.....	358.61
Clutch coil and small springs	211.13
Sliding disk.....	52.92
Two ram points.....	155.73
	\$1,190.36

Total expenditure over a period of 27 weeks \$4,160.77

*Net cost of water equals 26 cts. per 1,000 gallons. The cost of transport and delivery of water—namely: 44 cts. per

1,000 gallons—is included in the item of \$2,112.48.

Since the total quantity of rock broken in the 27 weeks was 24,535 cu. yds., the working cost per cubic yard is—

\$4,160.77	
————— = \$0.17	
24,535	
The cost of the rock breaker (including ram) was \$33,092.20, whence—	
Interest on capital at 4 per cent....	\$1,323.70
Depreciation at 2½ per cent.....	827.30
Insurance at 2 per cent.....	661.80
Total	\$2,812.80
Or \$1,460 for 27 weeks.	

So that the amount per cubic yard is—

\$1,460	
————— = \$0.06	
24,535	
Total cost of breaking rock (including interest, etc.) = \$0.17 + \$0.06 = \$0.23 per cu. yd.	

The 2½ per cent allowance for depreciation is in the author's opinion ample, assuming that the rock breaker is well maintained.

In estimating the probable cost of rock breaking over a period of years, allowance must be made, of course, for periodical docking and painting, but the ram constitutes the heaviest item of maintenance, owing to the wear by abrasion of the bottom 2 or 3 ft. There is also the liability of the ram fracturing, in the course of time, due to "fatigue." Messrs. Lobnitz & Co. state, as the result of their general experience, that the total cost of repairs and renewals will not exceed that of all the other working expenses put together, and the author believes this to furnish a safe basis for an estimate. Hence:

For 27 weeks—	
Average cost for wages, coal, stores, etc., as previously ascertained	\$2,970.43
The estimated allowance for cost of repairs and renewals (including periodical docking and painting), based on Messrs. Lobnitz & Co.'s estimate, can therefore be put at the maximum figure of 2,970.43	
Interest, depreciation and insurance, as above.....	1,459.95

Hence the estimated total cost of breaking rock, including interest, depreciation, etc., is—

\$7,400.81	
————— = \$0.30 per cu. yd.	
24,535	

The average cost of drilling and blasting sandstone rock at Blyth was \$0.72 per cu. yd. The drilling craft consisted of a barge, upon which was mounted a derrick and overhanging platform, an ordinary vertical boiler and a winch engine. The drills, six in number, were worked by hand, assisted by ropes attached to the drill crossheads, and led over sheaves at the top of the derrick to barrels upon a long shaft driven by the winch. The winch was kept continu-

ously running, and the lifting and releasing of the drills were effected by alternately tightening and slackening two or three turns of the rope around each barrel. Bellite was the explosive used, and an average of about 488 cu. yds. of rock per week were broken, the craft working night and day.

In comparing the removal of large quantities of rock by the rock breaker and by blasting, the following are the chief points in favor of the rock breaker, viz.: (1) Considerably less cost; (2) the rock is broken at a quicker rate; (3) the rock is broken to a more convenient size for dredging, so as to increase the rate of the latter operation by about 15 per cent; (4) the rock can be broken at places where it would be injudicious to use explosives; (5) freedom from the danger incidental to the use of explosives.

The engineers to the Blyth Harbor Commissioners are Messrs. J. Watt Sandeman & Son of Newcastle-upon-Tyne, and the author is the Resident Engineer.

Some Drilling Records; the Daily Cost of Maintaining Electric Air Drills, and the Advantages of This Drill in "Sticky" Rock.

Mr. Wallace F. Disbrow, mining engineer, of Mineral Point, Wis., and superintendent of the Merry Christmas lead and zinc mine, has kindly furnished us with the following data on operating two Temple-Ingersoll electric air drills, manufactured by the Ingersoll-Rand Co. of New York.

The drill mounted on a tripod or column is operated by air from an air pulsator under control of the drill runner, the pulsator being driven by an electric motor. This mining company has two of these drills in operation. These drills are of the 4D size, having a cylinder 4¾ ins. in diameter and a 7-in. stroke. The drill is designed to carry 10 ft. of steel in drilling vertical holes. This makes the work done similar to that of a 2¾-in. steam or air drill. The motors used on these drills were from 3 to 5 H.P., a 3 H.P. motor being used on low speed and 5 H.P. on high speed.

These two drills have been operated in the Merry Christmas mine for the past six months in a rather soft limestone formation. Although the rock was soft, it was exceedingly sticky and a heavy and a gummy sludge was formed, making the drill work exceedingly difficult. In fact, so great is the influence of this factor in drilling, that formerly, with 80 lbs. pressure on the old style air drill, it was extremely difficult to put down a hole and extract the 6 ft. drill steel even when the hole was well watered. Mr. Disbrow states that "The Temple Ingersoll drills, with their powerful plunging stroke, are able to handle a 12-ft. steel down to the chuck without a stop if the machine is properly han-

dled. In fact we have noted many times that when the hole was not sufficiently watered, the steel would still go down and keep turning, so that when the hole was finished, it would be almost impossible to extract the steel with a wrench."

This long stroke is an important factor in drilling holes wherever the sludge forms quickly, as the drill point thus helps to keep the bottom of the hole free of the sludge. With a short stroke the sticky sludge hangs much closer to the bottom of the hole, cushioning the blow, and sometimes stopping the drill. To keep the hole well watered in either case is a great help to the drill. For an article on the use of the water jet in drilling in soft rocks, see *ENGINEERING-CONTRACTING*, Feb. 5, 1908, page 84, where a formula is given for estimating the amount of water needed.

The drills in the Merry Christmas mine are not used continuously. Upon one occasion one drill put down 63 ft. of hole in two hours, the average depth of holes being 5 ft., making a record of 31½ ft. per hour. On another day a drill sunk two rounds of 12 holes each, to an average depth of 5 ft. For this work the drill was set up twice, as each round of holes were shot. This meant the drilling of 120 lin. ft. of holes, the time being 5½ hours, or at the rate of 21.8 ft. per hour, including making the extra set up.

The cost of maintenance of these two drills for six months has been about 20 cts. per day per drill. The principal parts to wear were chuck bushings, hose, front head cup leathers and chuck pins. The hose is the largest item of renewals as soon as the slightest leak appears it must be discarded.

The cost of electric power for these drills has been with power at 5 cts. per K.W., for a single drill per day, \$1.00, as about 20 K.W. is the average consumption of power.

For other articles on the electric air drill, see *ENGINEERING-CONTRACTING* May 27, 1908, p. 318, and Dec. 9, 1908, p. 392.

The first annual meeting of the American Institute of Chemical Engineers is to be held Dec. 28-29, at Pittsburg, Pa. Among the papers announced for this meeting are the following: "Technical Coal Analysis," Edward Gudeman; "The Chemical Aspect of Impurities Which Cause Scale and Corrosion of Steam Boilers," J. C. William Greth; "The Examination of Flue Gases in Boiler Tests," H. August Hunicke; "The Utilization of Low Grade Fuels in the United States," O. K. Zwingerberger; "Work of the U. S. Government Fuel-Testing Plant at Denver, Colo.," A. W. Belden; "Heating of Industrial Furnaces with Pulverized Fuel," Richard K. Meade; "Modern Electrical Resistance Pyrometry," Edwin T. Northrup; "The Sanitary Condition of the Southern End of Lake Michigan," J. H. Brewster; "Cement Manufacturing Methods," J. G. Dean.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Law Suit for Use of Oil and Water on Roadways Decided in Favor of the Public.

A decision which is expected to be of far reaching importance, affecting the rights of the public generally to use oil and water in laying dust in streets and roadways, was rendered by Judge Kohlsaot of the U. S. Circuit Court, at Chicago, on December 10, in the case of the Westrumite Company of America vs. The Commissioners of Lincoln Park, of Chicago.

The Westrumite Company claimed a patent upon the use of any mixture of oil and water to lay dust. The practice of using oil to lay dust has of late years come to be well recognized generally, and it is coming more and more into common use. The above company began a suit against The Lincoln Park Commissioners about a year ago to enjoin their use of oil and water in mixture, and to collect damages for infringement, the Park Commissioners having freely used an emulsion of oil and water to sprinkle their roadways.

A victory of the Westrumite Company in this suit, if sustained in the upper courts, would mean that no one could use oil and water mixed in any way in laying dust, without paying a royalty to the company for so doing. The decision in the case turned upon the question whether the mixture of oil and water, particularly crude petroleum and water, and sprinkling it on dusty roads could be the subject of a valid patent, and also involved whether, as a matter of common knowledge, oil and water can be combined in solution.

It was argued by William R. Rummler and Charles A. Churan, attorneys for the Commissioners of Lincoln Park, that, inasmuch as the patent states that in practicing the process the oil is first "rendered soluble in water by any known process," and inasmuch as it is a matter of common knowledge that oil is not soluble in water, therefore the patent was fatally defective; also that, inasmuch as the patent claims the sprinkling upon the roadways of any mixture of oil and water, without specifying how such mixture should be made, except by the erroneous statement that the oil is dissolved in water, therefore the patent failed to disclose anything of value to the public in consideration for the 17 years monopoly granted by the patent, and that therefore the grant was void on its face, and that the suit should be dismissed without putting the parties to the expense of introducing further evidence. Judge Kohlsaot sustained this contention and dismissed the suit.

The Westrumite Company makes a preparation which it calls "westrumite," and which it has sold to park boards in different parts of the country for use in sprinkling their boulevards and roadways. It has realized royalties in this way under its patent, the number of the patent being 752,487, dated Feb. 16, 1904, and issued to L. S. Van Westrum.

The patent has five claims which are as follows:

1. The method of utilizing the granulated portions of road-beds or streets by forming them into a top dressing or coating, by first mechanically or chemically mixing in predetermined proportions oil and water, then sprinkling or spreading the said mixture over said loose granulated substance or dust and permeating the same, thereby unifying them and forming a concrete mass which adheres to the solid surface of the street or roadbed, thus preventing the diffusion of dust and forming the said top dressing.

2. The method herein described of first taking say ten parts of oil, then ninety parts of water, then mixing the same in solution, then distributing the mixture over a surface of granulated substance by which the granules are united in a thin stratum, whereby their diffusion or scattering is prevented.

3. The method herein described of improving the surface of road-beds and utilizing the loose granulated particles thereon by sprinkling or coating them with a mixture of oily substances composed of predetermined proportions of oil and water, whereby the said substances are caked or mixed to form a coating for the purpose specified.

4. The method of utilizing the granulated portions of road-beds or streets known as dust and forming it into a top dressing by permeating it with an oily substance consisting of oil and water previously and intimately mixed, whereby the said granulated particles are unified with oil and water and form a concrete mass in the manner and for the purposes specified.

5. The method herein described of saturating scattered dust and mixing the same with a mixture of oil and water in the proportions specified in such a manner that said dust is made to adhere to its bed, substantially as described.

A contract for dredging at the U. S. Naval Station, Honolulu, Hawaii, has been let to the Hawaiian Dredging Co., Honolulu, at \$3,560,000.

Asphaltic Concrete Pavement Surfaces

Asphaltic concrete pavement surfaces are described briefly in a paper by Mr. Clifford Richardson on "the maintenance of highways in view of the advent of the motor vehicle" submitted at the First International Road Congress, at Paris. He states that a properly graded aggregate consisting of a large majority of coarse stone, the voids in which are filled with finer stone and different sizes and with sand, when cemented together with a suitable asphalt cement, results in a concrete surface which is very resistant to traffic. Such a surface was constructed by Mr. Richardson in 1902 at Muskegon, Mich., and has served, with no cost for maintenance, until the present day. The surface at Muskegon is supported upon a broken stone foundation of 2-in. stone 6 in. thick.

On the Thames embankment, in London, England, where very great difficulty has been met in maintaining an ordinary macadam highway, owing to the concentrated traffic, largely of motor cars, which exists there, an asphaltic concrete was laid by Mr. Richardson in 1906, the surface of which was covered with a thin layer of the ordinary type of American asphalt pavement for its better protection. This work has been a complete success, and its extension is promising.

In producing an asphaltic concrete of the type described, a broken stone, none of the particles of which are larger than 1 in. in dimension and containing a considerable proportion of grit, $\frac{1}{4}$ in. material, is heated in a dryer and separated into two sizes by passing over a screen having perforations $\frac{3}{8}$ in. in diameter. These are collected in separate bins. At the same time, sand of a suitable grading, such as is used in the American form of sheet asphalt pavement, is heated and collected in another bin. These three components are combined in the proper proportion and mixed together while still hot, and a suitable amount of asphalt is added. The proportions in use on the Thames embankment in London were as follows:

	Lbs.	Per ct.
Asphalt cement	56	7.2
Dust	21	2.7
Sand	216	27.9
Grit	173	22.2
Stone	310	40.0
	776	100.0

Such an asphaltic concrete has the composition given below:

	Per cent.
Bitumen	7.2
Passing 200 mesh screen.....	3.0
Passing 10 mesh screen.....	30.2
Passing 8 mesh screen.....	1.5
Passing $\frac{1}{4}$ inch screen.....	13.8
Passing $\frac{1}{2}$ inch screen.....	11.2
Passing $\frac{3}{4}$ inch screen.....	14.7
Passing 1 inch screen.....	14.8
Retained 1 inch screen.....	3.6
	100.0
Voids in mineral aggregate	17.6

General Figures in the Cost of Road Construction in Various Parts of the United States.

So many factors enter into road construction that a comparison of the average cost of roads in various parts of the United States is of little value unless all of the conditions are taken into account. The great variation in climate, soil, topography, cost of labor, and character and quantity of road material in this country, naturally lead not only to a great diversity in the kinds of roads built, but also to a wide variation in the cost of road building. In a report submitted at the First International Road Congress, at Paris, France, Mr. Maurice O. Eldridge, Chief of Records, U. S. Office of Public Roads, gives much information on the cost of road building in various parts of the United States, and from this report we have taken the matter in this article. The figures given by Mr. Eldridge were taken from the various State reports and from the records of the U. S. Office of Public Roads.

Object Lesson Macadam Roads.—For a number of years the U. S. Office of Public Roads has been assisting local authorities in various parts of the United States in building short sections of roads for experimental purposes and for object lessons. In this work the Government furnished the engineers and experts to direct the work and such machinery as was necessary, while the local authorities supplied the common labor, teams, fuel, etc. The average cost of a number of macadam roads built from 1904 to 1907 under the direction of the U. S. Office of Public Roads ranged from \$7.707 to \$3,082 per mile. For six roads—four in the State of Washington and two in Oregon—in the Pacific Coast Division, the average cost per mile was \$7,707 and the average cost per sq. yd. was \$839. The aggregate length of these six roads was 17,358 ft.; the average width was 15.7 ft., and the average depth of stone was 7.6 ins. The wages ranged from \$1.50 to \$2.50 per day for common labor and \$3 to \$4.50 for a double team and driver.

For eight roads in the Western States Division—five in Missouri, one in Nebraska and two in Kansas—the average cost per mile was \$5,123, and the average cost per sq. yd. \$657. The aggregate length was 28,368 ft.; the average width was 13.1 ft., and the average thickness of stone was 8.2 ins. The wages of common labor varied from \$1.25 to \$1.50 per day for labor, and from \$2 to \$3 for double team and driver. This division exhibits the greatest variation in cost, one road at Lebanon, Mo., costing \$1,769 per mile, while a road at Auburn, Neb., cost \$12,496. The latter road was surfaced to a width of 15 ft. and a depth of 10 ins., and was built over a marshy river bottom which made necessary a heavy stone curb on the upper side for the entire length. The cost of

this curb is included in the cost given above. The Lebanon, Mo., road was surfaced only to a width of 9 ft., the cost of labor was only \$1 per day and the material was obtained by the roadside.

For four roads in the Northern States Division—one in Illinois and three in Ohio—the average cost per mile was \$5,750, and the average cost per sq. yd. was \$748. The total length of the four roads was 12,080 ft.; the average width was 13.1 ft., and the average depth of stone was 9.3 ins. Wages varied from \$1.50 to \$1.75 per day for labor; double teams and drivers were paid at the rate of \$3.50 per day.

For six roads in the Southern States—one in Florida, three in Alabama, one in Virginia and one in Maryland—the average cost per mile was \$3,082 and the average cost per sq. yd. was \$418. The total length of the six roads was 23,066 ft.; the average width was 12.8 ft., and the average depth of stone 6.2 ins. Wages varied from \$1.75 to \$1.50 per day for labor and \$2.25 to \$4 per day for double team and driver.

The above costs include small culverts and bridges and the cost of grading, but does not include cost of engineering supervision or the cost of machinery. All but one of the roads was built by day labor.

Cost of Sand Clay Roads.—The cost of a number of sand clay roads built in 1904-06 in various Southern States under the direction of the U. S. Office of Public Roads is shown in the accompanying table:

Place.	Length, in ft.....	Width, in ft.....	Depth, in ins.....	Cost, per sq. yd.....	Cost per mile.....
Tallahassee, Fla.	4,480	16	7½	\$0.055	\$ 516.27
Pensacola, Fla.	1,800	15	8	.140	1,232.00
Gainesville, Fla.	5,280	14	9	0.107	\$81.25
Kenansville, N. C.	5,900	20	6	0.033	387.18
Kinston, N. C.	600	16	6	.030	276.92
Newbern, N. C.	800	12	6	.027	190.00
Washington, N. C.	2,700	14	6	.090	739.13
	21,560	*16.1	*7.1	*\$0.068	*\$ 639.22

*Average.

The first three roads were built in 1904-05, the average cost of labor being \$1 per day. The last four roads were built in 1905-06, the cost of labor per day varying from \$1.75 for the Kinston and Newbern roads to \$.80 and \$1 for the Kenansville and Washington roads. The cost of teams was \$2.50 per day for the Kenansville and Washington roads and \$2 for the Kinston and Newbern roads. The average cost of these sand-clay roads was \$639 per mile, or 6.8 cts. per sq. yd. The average width of the sand-clay roads built was 16.1 ft., and the average depth of sand-clay mixture was 7.1 ins. Some of these roads were improved by mixing sand with the surface of the clay road, while others were improved by treating the sandy roads with clay. The mixing was usually done with

disc harrows or plows, when the materials were damp. The cost depends principally upon the depth treated, the distance materials have to be hauled, and the cost of labor.

Cost of Macadam Roads in Massachusetts.—During the period 1895-1907, 557.78 miles of macadamized road was built in Massachusetts under the direction of the State Highway Department. The average cost of these roads, exclusive of cost of bridges and engineering charges, was 91.6 cts. per sq. yd., or \$7,662 per mile. This cost does not, however, include the cost of the bridges or of engineering. The standard width of macadam surface in Massachusetts is about 15 ft. and the average depth of material after consolidation, 6 ins. in the center and 4 ins. on the sides. They were constructed principally of trap rock and granite. There was a general reduction in the average cost of macadam roads in Massachusetts from 1895 to 1905, the average cost of the roads constructed in 1895 being \$9,951 per mile, and in 1905 the average cost was \$5,709 per mile. This appears to be due to the fact that, when the work of building stone roads was begun about 1895 the poorest sections of road were selected for improvement. This usually necessitates more grading than would be the case under ordinary circumstances, and the use of a greater quantity of material. This policy tended to high cost of roads with a gradually decreasing average cost as the roads were extended, and the less difficult sections were built. The increase in cost from 1905 to 1907, the average cost in the latter year being \$7,469 per mile, is probably due to the increase in the cost of labor, there having been a general increase in the cost of labor throughout the United States during this period.

Roadwork in Connecticut.—During the period 1899-1906, 613,519 ft. of macadam road was built in Connecticut under the direction of the State Highway Commission. The average cost of these roads was \$6,072 per mile, or 67.5 cts. per sq. yd., and includes the cost of grading and engineering. The average width of all macadam surfaces was 15.4 ft., and the average depth 6.74 ins. The cost of the macadam roads in this State has steadily increased, the average cost in 1899 for a 16.5 ft. wide, 6.6 in. deep road being \$4,984 per mile, or \$490 per sq. yd., while in 1906 the average cost for a 14.7 ft. wide, 6.9 in. deep road was \$7,018 per mile, or \$797 per sq. yd.

The average cost of 115,940 ft. of Telford roads built in Connecticut during the period 1899-1906 by the State Highway Department was \$7,965 per mile, or 98.6 cts. per sq. yd. This includes the cost of grading. The average width of the surface of these roads appears to be 14.6 ft., and the average depth of material 14.9 ins.

The average cost of 465,220 ft. of gravel roads built in the State during the period 1899-1906 under the direction of the State Highway Department was \$3,742 per mile,

or 39.1 cts. per sq. yd. The average width of surfacing on these roads was 15.5 ft. and the average depth of consolidated material 8.3 ins.

In both these types of roads there has been a gradual increase in the cost of construction, this being particularly noticeable in the case of gravel roads. In 1899 the average cost of an 18.4 ft. wide, 9 in. deep gravel road was \$2,881 per mile, or \$274 per sq. yd. In 1906 the average cost of a gravel road 15.5 ft. wide and 8.2 in. deep road was \$7,140 per mile, or \$512 per sq. yd.

Roadwork in New Jersey.—The average cost of the 4,724,777 sq. yds. of macadam roads built in New Jersey under the direction of the State Highway Department during the period 1894-1907 was \$59 per sq. yd. As the average mile contained 7,744 sq. yds., the average cost per mile would be \$4,707. This does not include the cost of bridges, of engineering or of earth or rock excavation. The average width of the macadam surfaces on these roads was 13.6 ft. and the average depth of material 6.9 ins. In 1894 the average width of the New Jersey roads was 12 ft. and this was increased to 14 ft. in 1904; the depth of material, however, has gradually decreased from 8 and 9 ins. at first to 4, 5 and 6 ins. during the last few years. The cost per sq. yd. has ranged from 20 to 90 cts. In the lower part of the State the cost ranges from 50 to 60 cts. per sq. yd., while in the upper part of the State, where trap rock is quarried near the road, the cost ranges from 20 to 45 cts. per sq. yd.

The 1,517,659 ft. of Telford road constructed in New Jersey from 1894 to 1907 cost on an average of 71 cts. per sq. yd. The average width of the surface of these roads was 13.5 ft., the average depth of material 9.4 ins., and the average cost \$5,623 per mile. This does not include the cost of bridges, of engineering, or of earth and rock excavations. Most of these roads are built in sections of the State where rock is abundant and much of the Telford work is done from ledge excavation, which would otherwise be a waste product. The Telford method of construction was extensively used in New Jersey between 1894 and 1901, but since that time the majority of the roads are being built according to the macadam method.

The average cost of the 237.14 miles of State-aid gravel roads in New Jersey during the period 1896-1907 was \$2,426 per mile; which would make the average cost per sq. yd. 27 cts. The average width of these roads was 15.3 ft., and the average depth consolidated 8.44 ins. The average depth of gravel at bermes is usually about 2 ins. less than the average depth at the center of the roadway. While the average cost of gravel roads in New Jersey has gradually increased, the width of surface has also increased. The increased cost may

also be due in part to the increased cost of labor and to a longer haul of material.

Gravel and Macadam Roads in Indiana.—The average cost per mile of 1,951 miles of gravel road built in Indiana previous to 1904 was \$1,172 per mile, and the average cost of maintenance was \$87.58 per mile per year. The low cost of these roads is largely due to the fact that almost every county in the State is well supplied with gravel, which, when properly used, makes very satisfactory roads for ordinary traffic. The average cost per mile of these roads varied from \$300 to \$3,500. This is due to the fact that the conditions in no two counties are exactly alike. Many miles of these gravel roads have been built by the farmers in working out their taxes; and, from the low cost of the roads in some counties, it would appear that the full value of all the labor expended on the roads has not been included in the cost, or that only a small quantity of gravel was used in building them. Most of these roads were built simply by spreading from 8 to 12 ins. of loose gravel on the old road bed to a width of from 9 to 14 ft., and leaving it for traffic to consolidate. This simple method of construction accounts for the low cost in many counties. In several other counties, however, the gravel is carefully separated by means of screens, and steam rollers and sprinklers are used to roll the foundation and to consolidate the material.

For the 3,172 miles of macadam road which Indiana had in 1904 the average cost was \$2,210 per mile, the average annual cost of maintenance being \$48.46 per mile. Many counties in Indiana are well supplied with limestone suitable for road building, which accounts, in part, for the low cost of this class of roads. Another reason for the low cost is that in many cases the crushed material is spread on the unprepared foundations, the traffic being depended upon to consolidate it.

Oiled Roads in California.—Figures on the oiling of 1,796½ miles of road of an average width of 12 ft. between 1899 and 1901 are given by Mr. Eldridge in his report. The total cost per mile for the first year's treatment averages \$218 per mile, or 3.6 cts. per sq. yd. An average of 204 bbls. (42 gallons to the barrel) of oil was required for each mile of roadway. The average cost of oil by the roadside was 83 cts. a barrel and the average cost of applying was \$44.61 per mile of roadway. The cost per mile of oiling varied from \$55.32 per mile for a 12-ft. wide red clay soil road in Calaveras County, to \$450 per mile for 12-ft. wide sandy loam road in Sonoma County. The roads are usually oiled from one to three times each season, but the annual cost of maintenance is generally not more than one-fourth to one-half the first year's treatment.

Regarding these oiled roads, Mr. Eldridge states: "When the road is treated the first time the oil is usually applied to the surface, which has been previously pul-

rolled to a depth of from 1 to 6 ins. The mixing is done by plows and harrows and the rolling by steam or horse roller, but sometimes the traffic is depended upon to do the rolling. This method has not always given entire satisfaction for the reason that the roller usually consolidates only a thin crust of material, which sometimes scales off and leaves the road full of holes. A process recently evolved, however, tends to overcome this difficulty. Instead of rolling the oiled surface with a smooth faced roller, a roller weighing about 5,000 lbs. and provided with rows of flat headed teeth, is drawn back and forth over the mixture of earth and oil. At first the teeth sink 6 or 8 ins. into the surface, but each time the roller passes over the surface it rises a little out of the mass. Usually one gallon of oil per square yard is added as the rolling progresses, about two gallons having been applied before the rolling began. When the tamping is completed the mixture is so solid that the teeth no longer sink into the surface. A smooth-faced roller is then used in order to remove the prints left by the teeth. This method costs a little more than the method upon which the above cost data is based, but the process is of such recent origin that it has been impossible to secure cost data."

Irrigation work in Hawaii was described by Governor Walter F. Frear, at the annual meeting of the Washington Society of Engineers on Dec. 15. It was stated that only about \$15,000,000 have been expended in bringing water to a little over 100,000 acres. The work has been done by the sugar planters, who have found that the drier lands when properly irrigated are the most productive. At first, attempt was made to dig ditches similar in character to those in California, but experience has shown that better results can be attained by putting the ditches largely in tunnel. The country is so rugged that it is necessary either to wind the ditches for many miles along the faces of nearly vertical cliffs, or to go directly through the ridges by lines of tunnel, which, intersecting the various small streams bring these together and conduct them around the mountains, or directly through the high lands to the sheltered portions of the islands where the rains seldom come. Another striking feature of the engineering work has been the development of deep wells along or near the seashore on the leeward side, and the installation of large pumps lifting this water to heights as great as 550 ft. For this purpose there are now used rapid running, triple expansion reciprocating pumps with fly wheel and mechanically closing valves, pumping from two to ten million gallons per day. The cost of this water is far greater than that which has been reached on the mainland of the United States, being approximately for a 100-ft. lift, \$7 per million gallons

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Water-Works Valuation and Fair Rates in the Light of the Maine Supreme Court Decisions in the Waterville and Brunswick Wick Cases.

BY LEONARD METCALF, M. AM. SOC. C. E.
(Continued from p. 421, Dec. 16 issue.)

DEPRECIATION.

A water-works system has a limited life or period of usefulness. The structure suffers depreciation with the lapse of time. The various elements composing the physical plant have to be removed and replaced from time to time. Broadly speaking, this depreciation may be classified under physical and functional depreciation, and, in certain cases, perhaps, under a third class

growing out of expediency or extraordinary external requirements. By physical depreciation is meant the actual wear and tear of operation upon the structure; by functional depreciation, the obsolescence of the structure or its inability, for one reason or another, effectively to meet throughout its life the full requirements of the service. Thus the structure may suffer total depreciation and be thrown out of service, not only because through wear and tear it has reached a condition where further expenditures for repairs or attempts to make it suitable for the required service would not be economical or expedient, but also because recent improvements, or new inventions, new developments and radical changes in service, or the demands of one kind or another in-

BLANK USED IN COLLECTING WATER-WORKS STATISTICS.

	Place.....
Year	
Population	
Grav. or Pumpg.	
Miles of Pipe	
Pop. per mi. of pipe	
Range of Sizes	
% Wrought-Iron	
Taps in service	
Per 1,000 popul.	
Per mi. of pipe	
Meters	
% of taps metered	
Consump. annual m. g.	
Daily g. d.	
Per capita g. d.	
Per mi. of pipe g. d.	
Per tap g. d.	
Pressure (range) lbs.	
Hydrants-number	
Per 1,000 popul.	
Per mi. of pipe	
Bonds	
Rate of interest	
Capital Stock	
Floating Debt	
Gross Income Total	
Per capita	
Per mi. of pipe	
Per tap	
Per m. g. consump.	
Gross Inc. excl. Hyds.	
Per capita	
Per mi. of pipe	
Per tap	
Per m. g.	
Net Inc. excl. interest	
% of gross	
Per capita	
Per mi. of pipe	
Per tap	
Per mil. gals.	
Hydrant Rental	
Per hydrant	
Per mi. of pipe	
Taxes, annual	
Per \$1,000 bonds	
Cost of operation	
Per capita	
Per tap	
Per mi. of pipe	
Per mt. gals.	
% of gross income	

volving sweeping changes in the existing plant, make abandonment necessary.

The rates of depreciation of the different component parts of a water-works system vary greatly, both in the final limit of useful life and in the progress or rate of depreciation during that life. The deprecia-

culating the depreciation of cast-iron pipe, a consideration of the loss in carrying capacity would furnish an added criterion. It certainly does, although its direct application is impossible, for the reason that the pipe system is designed with some regard for this very factor—gradual loss in carrying capacity—hence, to charge a greater depreciation in the early life of the plant in addition to the burden of the greater pipe sizes used to meet this very contingency, would be to make a double charge against earnings. By this criterion the loss in the early years of the life of the pipes would exceed that resulting from the application of the sinking-fund method. The true results may lie somewhere between the two, though if the assumed life of the structure in the sinking-fund method be moderate, any allowance on this score may be excessive.

In the opinion of the writer, all these methods are but aids to judgment, and must be applied with care and discretion, and with a clear conception of the extent of the modifying influences or considerations; no subject in the engineering field requires richer experience or riper judgment. Obviously, the first and third or second and third methods may give identical results. The first method shows a smaller rate of depreciation in the earlier years, and a larger rate of depreciation in the latter years, of the life history of the plant under consideration, than does the second method. In valuation the third method can be applied as readily as the

charged off to depreciation annually, than to have lump sum amounts charged off as the service demands and the annual income or surplus may warrant. The former method of distribution should be no less accurate in a period of years, and should reduce the extremes of fluctuation in dividends. These general methods have been described so clearly elsewhere in the articles referred to herein, as to make extended comment unnecessary.

It may be said, however, that the work involved in calculating depreciation by the sinking-fund method is nominal when the probable useful life of the structure and rate of interest for the sinking fund have been determined, provided sinking fund tables are available.

Bond Formulas, Compound Interest, and Sinking Funds.—For the convenience of those who may have occasion to figure bond yields, interest, or sinking funds, when tables are not to be had, the following formulas are presented. They were collated, arranged, and annotated for the writer several years ago by one of his assistant engineers, Frank H. Carter, Assoc. M. Am. Soc. C. E. The authority for and reference to the formula is given in each case.

Bonds.— B = face of bond,
 R' = amount of \$1 for 1 yr. @ r' rate,
 P = price of bond,
 n = years bond has yet to run,
 r = rate of interest bond bears,
 r' = rate of interest at which coupons are reinvested,
 x = rate of interest which investment yields.

All rates of interest are here taken per year.

Common Method.—

$$P(1+x)^n = Br(1+r')^{n-1} + Br(1+r')^{n-2} + \dots + Br + B$$

$$= B + \frac{Br[(1+r')^n - 1]}{r'}$$

$$\therefore 1+x = \left\{ \frac{B}{P} + \frac{Br[(1+r')^n - 1]}{Pr'} \right\}^{\frac{1}{n}}$$

$$1+x = \left\{ \frac{Br + Br(1+r')^n - Br}{Pr'} \right\}^{\frac{1}{n}} \dots (1)$$

(Wentworth's Algebra.)

The Robinsonian tables are not figured on the basis of the above formula, but as follows:

Robinsonian Bond Values.—

$$\frac{(Br - Px)((R')^n - 1)}{r'} + B = P$$

$$Br(R')^n - Br - Px((R')^n - 1) + Br' = Pr'$$

$$\therefore P = \frac{Br[(R')^n - 1] + r'}{r' + x[(R')^n - 1]} \dots (5)$$

(After Robinson.)

or, as J. Watts Robinson assumes r' at 4%:

$$P = \frac{Br[1.04^n - 1] + 0.04}{0.04 + x(1.04^n - 1)} \dots (2)$$

$$x = \frac{0.04(B - P) + Br(1.04^n - 1)}{P(1.04^n - 1)} \dots (3)$$

$$\text{or } x = \frac{r'(B - P) + Br[(1+r')^n - 1]}{P[(1+r')^n - 1]} \dots (4)$$

(After Robinson.)

TABLE I.—SINKING FUND DATA.*

Life of structure.	Annual contribution to sinking-fund in percentage of first cost, with different assumed interest rates upon sinking-fund accumulations.			
Years.	3%	4%	5%	6%
5	18.8355%	18.4627%	18.0975%	17.7396%
10	8.7231	8.3291	7.9505	7.5863
15	5.3767	4.9941	4.6342	4.2993
20	3.7216	3.3582	3.0243	2.7185
25	2.7428	2.4012	2.0952	1.8227
30	2.1019	1.7820	1.5051	1.2649
35	1.6539	1.3577	1.1072	0.8974
40	1.3262	1.0523	0.8278	0.6462
45	1.0785	0.8262	0.6262	0.4700
50	0.8865	0.6450	0.4777	0.3444
55	0.7349	0.5231	0.3667	0.2537
60	0.6133	0.4202	0.2828	0.1876
65	0.5146	0.3390	0.2189	0.1391
70	0.4337	0.2745	0.1699	0.1033
75	0.3668	0.2229	0.1322	0.0769
80	0.3112	0.1814	0.1030	0.0573
85	0.2647	0.1479	0.0803	0.0427
90	0.2256	0.1208	0.0627	0.0318
95	0.1926	0.0987	0.0490	0.0238
100	0.1647	0.0808	0.0383	0.0177

Note.—Deposits at end of year compounded annually.

*Abstracted from "Robinsonian Bond and Investment Tables," by J. Watts Robinson.

tion may be at a uniform rate, or at a variable rate, or indeed at an irregular rate, depending upon various factors. Thus in the case of a reservoir, the structure may suffer substantially no depreciation until the time when it has to be abandoned by the requirements of larger size, greater pressure, or other detail of service; when this time does come, if the reservoir is actually abandoned, it suffers total depreciation, or, if it continues to serve a partial need, partial depreciation. A pumping engine may suffer virtually no depreciation in the first year of its life, indeed it may run more smoothly than when new; thereafter, it may depreciate steadily, if slightly, until it is outgrown and another larger machine has to be added, when it suddenly suffers a very large depreciation; it may then be used as an auxiliary machine for a portion of the time for a further period of years, until even this limited use proves uneconomical, though the engine may be held for emergency use for some time until it is finally abandoned, and only junk value less cost of removal remains. Clearly such a life history may be a very erratic one.

Three general methods of calculating the total depreciation of a water-works plant at any time in its life history, have been developed: First, the sinking-fund method; second, the constant-rate or straight-line method; and, third, what might be termed the individual analysis method, by consideration of the local conditions, more particularly with their reference to one another and their bearing upon the general efficiency of the plant.

Allen Hazen, M. Am. Soc. C. E. (and perhaps others) has suggested that in cal-

TABLE II.—SINKING-FUND DATA.*

Annual contribution to sinking-fund.	Approximate age at maturity or life of structure, with different assumed interest rates upon sinking-fund accumulations.			
	3% Years.	4% Years.	5% Years.	6% Years.
1%	87	72	62	55
1 1/4%	74	63	55	49
1 1/2%	66	56	49	44
1 3/4%	59	51	45	41
2%	54	47	42	38
2 1/4%	50	44	39	35
2 1/2%	47	41	37	33
2 3/4%	41	37	33	30
3%	37	33	30	28
3 1/4%	34	30	28	26
3 1/2%	31	28	26	24
3 3/4%	27	24	23	21
4%	23	22	20	19
4 1/4%	21	19	18	17
4 1/2%	19	17	17	16
4 3/4%	16	15	14	14
5%	14	13	12	12
5 1/4%	12	12	11	11
5 1/2%	11	10	10	10
5 3/4%	10	9	9	9
6%	9	9	8	8
15%	6	6	6	6
20%	5	5	5	5

Note.—Deposits at end of year compounded annually.

*Abstracted from "Robinsonian Bond and Investment Tables," J. Watts Robinson.

others, but in accounting—in the operation of a water-works plant—the first two methods are the more specific, easier and more certain of application. In operation it is generally more satisfactory to the stockholders to have an agreed and known percentage of first cost or of income

In the following table interest is compounded semi-annually.

Formulas 2 and 3 differ from all other bond value formulas in this: that the values are computed on the hypothesis that the reinvestments of interest necessary to compensate for the premium or discount at which a bond is bought are here invariably made at the rate of 4 per cent per

a_2 = annuity payable at end of year,
 a_1 = annuity payable at the beginning of each year and at the end of last year,

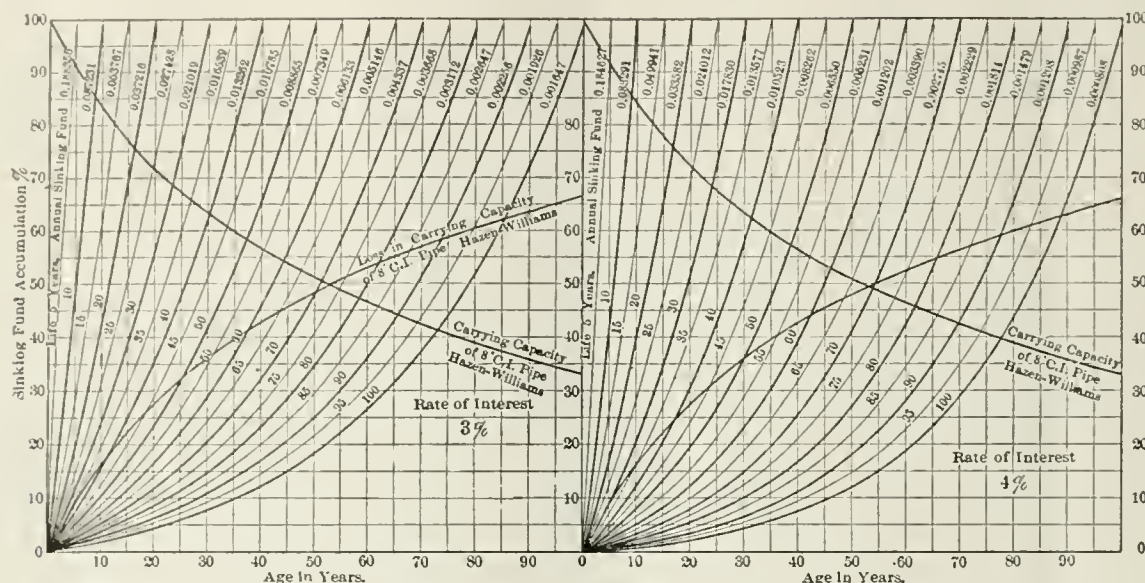
S = amount of sinking fund at end of n years,

$A = P \left(1 + \frac{r}{q}\right)^{qn}$; or if $q = 1$: $A = PR^n$. Compound interest (Wentworth's Algebra, p. 377.)

$a_2 = \frac{P R^n (R - 1)}{R^n - 1}$. Annuity payable at end of year. (10)
 (Well's Algebra, p. 381.) (Wentworth's Algebra, p. 379.)

$S = \frac{a_1 (R^{n+1} - R)}{R - 1}$. Sinking fund, payment at beginning of year. (11)
 (After Frizell.)

$a_1 = \frac{S (R - 1)}{R^{n+1} - R}$. Annual payment made at



Sinking Fund Diagram, Interest Compounded Annually—Contributions at End of Year.

annum.

Compound Interest and Sinking Fund Formulas.—

B = face of bond,

P = principal, or present worth,

r = rate of interest on one dollar for one year,

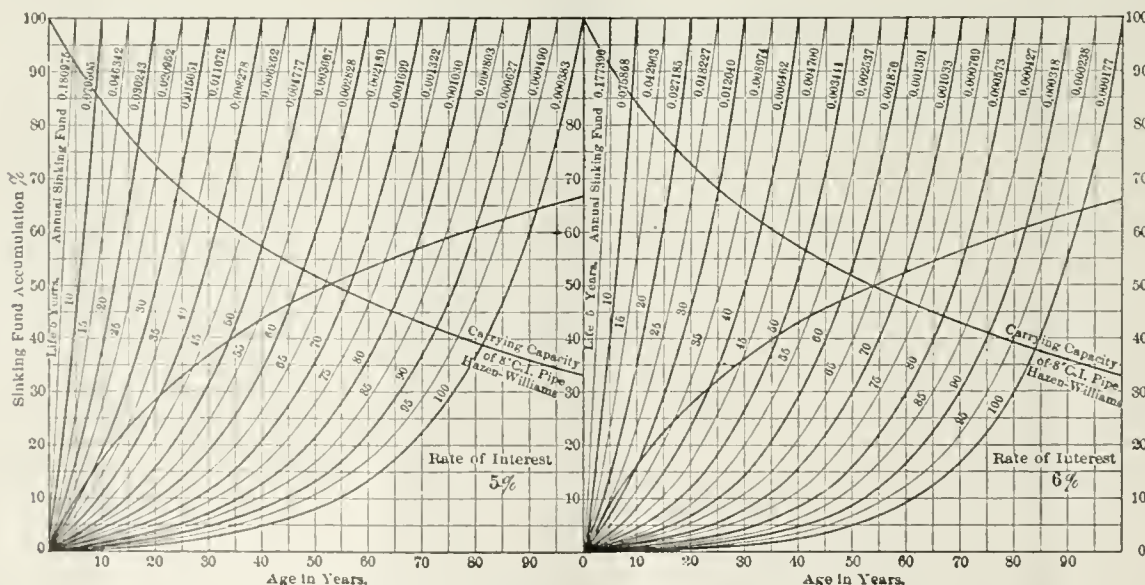
$P = \frac{A}{\left(1 + \frac{r}{q}\right)^{qn}}$; or if $q = 1$: $P = \frac{A}{R^n}$. Present worth. (6)
 (Wentworth's Algebra, p. 377.)

$P = \frac{a_1 (R^{n+1} - R)}{R^n (R - 1)}$. Present worth of annuity payable at beginning of year. . . (7)
 (F. H. C.)

beginning of year to establish sinking fund. (12)
 (After Frizell.)

$S = \frac{a_2 (R^n - 1)}{R - 1}$. Sinking fund, payment at end of year. (13)
 (After Frizell, p. 94.)

$a_2 = \frac{S (R - 1)}{R^n - 1}$. Annual payment at end of



Sinking Fund Diagram, Interest Compounded Annually—Contributions at End of Year.

R = amount of one dollar for one year,
 n = number of years,

A = amount of P for n years,

q = number of times in year that interest is payable,

a_1 = annuity payable at beginning of year,

$a_1 = \frac{P R^n (R - 1)}{R^{n+1} - R}$. Annuity payable at beginning of year. (8)
 (F. H. C.)

$P = \frac{a_2 (R^n - 1)}{R^n (R - 1)}$. Present worth of annuity payable at end of year. (9)
 (Well's Algebra, p. 381.)

year to establish sinking fund. (14)
 (After Frizell, p. 94.)

$P = \frac{a_2}{R - 1}$. Present worth. Perpetual annuity. (15)
 (Well's Algebra.)

$P = \frac{a_2 (R^n - 1)}{R^{n+1} - R}$. Present worth of an

annuity to begin after m years and to continue for n years (16)
(Well's Algebra.)

$P = \frac{a_2}{R^m(R-1)}$. Present worth of perpetual annuity to begin after m years... (17)
(Well's Algebra.)

$P = \frac{a_3(R^{n+1}-1)}{R^n(R-1)}$. Present worth annuity..... (18)

$a_3 = \frac{PR^n(R-1)}{R^{n+1}-1}$. Annuity from P ... (19)

$S = \frac{a_3(R^{n+1}-1)}{R-1}$. Sinking fund..... (20)

$a_3 = \frac{S(R-1)}{R^{n+1}-1}$. Annual payment to establish sinking fund in n years with $n+1$ payments (21)
(After Robinsonian Tables.)

The annual payments to be made at the beginning of each year and at the end of the last year, or $n+1$ payments will be made.

Method of Comparing Economy of Structures.—*

A = first cost,

X = repairs at intervals of s years,

n = life of structure,

D = value at which plant may be sold at end of n years,

C = capital involved at present,

r = rate of interest,

q = number of times in 1 year that interest is payable.

$$C = A + \frac{X}{\left[\left(1 + \frac{r}{q}\right)^{qs} - 1\right]} + \frac{A-D}{\left[\left(1 + \frac{r}{q}\right)^{qn} - 1\right]} \quad (22)$$

Proof of Formula 22:

By Formula 15,

$$P = \frac{a_2}{R-1}, \text{ and } a_2 = P(R-1)$$

By Formula 13,

$$X \text{ or } S = \frac{a_2(R^n-1)}{R-1} = \frac{P(R-1)(R^n-1)}{R-1} = C \left[\left(1 + \frac{r}{q}\right)^{qs} - 1 \right]$$

$$C' = \frac{X}{\left[\left(1 + \frac{r}{q}\right)^{qs} - 1\right]}$$

Formula 22 is a very close approximation. To be exact, the numerator in the third term should contain

$$\frac{-X}{\left[\left(1 + \frac{r}{q}\right)^{qs} - 1\right]}$$

assuming at the same time that n is a multiple of s .

As to the period of life of different portions of the water-works plant, opinions vary with the views and experience of the engineer or man rendering judgment, and many local circumstances and conditions affect the efficient or useful life of the structure and hence the depreciation very materially. Generally, however, the useful life of those structures has been assumed by different engineers, testifying in water-works valuation cases, to lie between the general limits given in Table 3.

The figures for depreciation in Table 3 may be largely exceeded. In a rapidly

growing, young community, the efficient life of the structure may be very short; pumps may be outgrown and discarded within 5, instead of 20 to 30, years' time; pipe may be replaced in 10 years or even less, etc.; and yet reasonable prudence may have been exercised in the original design; but the promise of development, or direction of growth, or character of the demands of the service, may have been too uncertain to warrant larger outlay and more liberal design in the original construction.

In principle, therefore, every water company should "write off" or deduct annually from its assets a sum which will, at least, cover this depreciation, and the writer is of the opinion that, inasmuch as this allowance has to be made in advance of the development of the facts and testing of the structure, a liberal policy should be adopted in order to ensure reasonably the future integrity of the capital invested in the plant in so far as this phase of operation is concerned.

The total annual depreciation will gen-

longer term bonds—the terms of which in some cases exceed the probable life of the structure. This practice is to be condemned unless the sinking-fund requirements correct this evil; even then this practice appears illogical.

Renewals.—Engineers are somewhat divided in opinion as to the necessity of charging off to depreciation any portion of renewals involving a betterment of the service. Some contend that renewals involving betterments of service—there being no difference of opinion, of course, in regard to renewals which are mere replacements of existing structures—should be charged in part only to construction; or, in other words, that the value in the original structure not previously written off in depreciation should be deducted from the construction account simultaneously with the addition to it of the increment of value in the renewal represented by the betterment of the service; while other engineers contend that the entire cost of the element of the renewal representing the betterment of the service,

TABLE III.

	Useful life.	Annual contribution to Depreciation Account or Sinking Fund in per cent of cost.	
		At 5% annual rate sinking fund.	General approximate results.
Reservoirs	50-100 years*	0.4777%-0.0383%	$\frac{1}{2}$ -0%
Standpipes	25-40 "	2.0952%-0.8278%	2-1%
Masonry buildings.....	40-50 "	0.8278%-0.4777%	1- $\frac{1}{2}$ %
Wooden buildings.....	20-50 "	3.0243%-0.4777%	3-1%
Cast-iron pipe of large diameter.....	50-75 "	0.4777%-0.1222%	$\frac{3}{4}$ - $\frac{1}{4}$ %
Cast-iron pipe of small diameter.....	20-40 "	3.0243%-0.8278%	3- $\frac{3}{4}$ %
Steel pipe.....	25-50 "	2.0952%-0.4777%	2- $\frac{3}{4}$ %
Wood-stave pipe.....	20-30 "	3.0243%-1.5051%	3-2%
Wrought-iron service pipe.....	15-30 "	4.6342%-1.5051%	5-2%
Meters	20-30 "	3.0243%-1.5051%	3-2%
Hydrants	40-50 "	0.8278%-0.4777%	1- $\frac{1}{2}$ %
Gates	40-50 "	0.8278%-0.4777%	1- $\frac{1}{2}$ %
Pumping and auxiliary machinery.....	20-30 "	3.0243%-1.5051%	4-2%
Steam engines.....	15-25 "	4.6342%-2.0952%	5-3%
Boilers	12-16 "	6.2825%-4.2279%	6-4%
Electrical machinery.....	20-30 "	3.0243%-1.5051%	4-2%
Average for entire plant (gravity system).....			1% to $\frac{1}{2}$ %
Average for entire plant (pumping system).....			2% to $\frac{1}{2}$ %

*Except where subject to heavy deposit of silt.

erally be found to lie between the following limits:

For gravity works from $\frac{1}{2}$ % to 1%.

For pumping works from $1\frac{1}{2}$ % to 2% of original cost, though considerable variations from these limits will be found, owing to the abnormally high functional depreciation resulting from errors in judgment, the development of structural weakness, faulty design, or from an over-niggardly policy in original construction, and to a multiplicity of other causes.

Sinking Fund as a Substitute for Depreciation.—As a matter of fact, while few municipalities have recognized this depreciation or perhaps even considered the underlying theory of it, they have, in effect, made allowance for it in the sinking-fund provisions of the bonded debt, and it may be added that the sinking-fund requirements have usually been in excess of the necessary allowance for depreciation, as a result of the assumption of a shorter life for the bonds than the actual life of the structures covered by them, though, perhaps, there is a tendency today to issue

should be charged to construction account, without any deduction on account of the remaining value in the original structure which has been sacrificed or lost, upon the theory that the betterment is demanded by increased business or larger requirements, and that hence the new business should carry the entire burden of the larger debt thus created. To take a concrete example, let us suppose that the growing needs of a community necessitate the relaying of a 6-in. pipe with a 12-in. pipe. Upon the first theory the water-works company would be entitled to charge to construction account only the difference between the entire cost of the 12-in. pipe and the remaining value (*i. e.*, not yet written off) in the 6-in. pipe, the rest being charged to renewals in offset to depreciation; upon the second theory, the entire cost of the 12-in. pipe might be charged to construction account upon the theory that the 6-in. pipe was still adequate to meet the requirements for which it was laid, and that the larger main was required by the greater demands of added business which should therefore

*C. F. Swain, M. Am. Soc. C. E., Journal, N. E. W. Vol. II, March, 1888, No. 3, p. 32.

carry the entire cost. Furthermore, say experiments of the second theory, the saving in interest upon the smaller original structure during its life, as compared with the larger structure had it been built, has more than covered the cost of the smaller structure, to which it is replied, that this fact has no significance beyond pointing the limits of rational design.

LAND, WATER RIGHTS, ETC.

Real estate must, of course, be valued on the basis of its market value and not upon the foregoing rules.

Monopoly Value of Land and Water Rights.—While the Maine Courts have laid down the rule that the public is entitled to the most advantageous development, it does not appear that consideration shall not be given to the fact that in some cases what may be loosely termed a monopoly value may attach to a property of this character. Take the case, for instance, of a reservoir site, where several alternate and equally advantageous sites are available, no particular value can attach to any one property in excess of its market value. If, on the other hand, there be but one site which can be used for this purpose without going to great expense in obtaining another, additional value in excess of the market value would appear to inhere in this property. Under some circumstances, perhaps, the limit of this value might be equivalent to a saving in construction upon this site, as compared with a less favorable site, or with the cost of an alternate method of accomplishing the same results, or with the additional cost of modifications in the design of the plant to meet the same ends. Generally speaking, however, this increment in value will be measured not in the manner stated, but by the additional sum of money which a purchaser would have been likely to give for this property when he purchased it, in advance of the construction of the works, in view of the possible use of this property by the company at a later date. A prospective purchaser would undoubtedly pay a larger sum for property with such inherent possibilities, but on the other hand, if there was a possibility of his having to hold the land for a considerable period of years, he might consider this additional speculative value as small.

COMMODITY VALUE.

The idea of attempting to value water delivered through a pipe system as a commodity, appears to be fundamentally wrong except under such conditions as might prevail in a desert or where water is not to be found locally, or within reasonable distance for transmission by pipe system, and the writer has certainly not chanced to hear of any case in which valuation of water as a commodity has had standing. To state that water, where the supply of potable and suitable water is manifestly in excess of present or prospective needs of the community, can have value for many and diverse uses as a true commodity, ap-

pears contrary to the fact. The value of the water to the community, aside from possible uses for the development of power, is created solely by the demand for water supply for public, domestic and manufacturing uses in the particular community under question, and that, moreover, in a limited quantity. It has value only to the limit of the demand or market for it; in short, the only market for this water is a local one, and if there be several possible alternative sources of supply, the water actually in use derives its value, not from the fact that it is a commodity, but from the existence of the franchise under which the company is operating and from what might otherwise be considered thereunder as monopoly value in water supply, that is, the right to sell water in a given community for profit, usually under non-competitive conditions. The water has value to the company, not solely from the fact of its existence, but also from the company's charter or franchise right to distribute it and to collect toll; therefore, the commodity theory is weak in that it entirely overlooks the duty of the company, under common law rules and the Maine decisions, to furnish water service to the consumer at a price that is fair in any event. Far from being a commodity value, this value is predicated upon the fact of service and worth to the consumer, and is fundamentally dependent upon the franchise which gives monopolistic value to the water by prescribing non-competitive conditions.

LIABILITY OF WATER COMPANIES FOR FIRE LOSS DUE TO INEFFICIENT SERVICE.

A consideration which, heretofore, probably has had little weight in water-works valuation, but which may depreciate properties of this character permanently, is that of the financial liability of water companies for loss incurred by fire, in which inadequate fire service can be proven. Court decisions have been numerous upon both sides of this question, but the weight of decisions has—before the Greensboro decision—been largely in favor of the water companies, upon the technical ground that, inasmuch as the water consumers were not parties to the contract of the water company to furnish water to the city for fire protection (or, to use a safer word, water for fire service), they could not sue the water company for breach of contract. Judge Brewer of the Supreme Court in the appealed Greensboro Water Company decision,* however, has taken the view of the water company liability, based upon the broad ground of negligence, a decision of far-reaching importance to many water companies, suggesting the need of the greatest care in the preparation and wording of fire-service contracts.

(To be continued.)

*Guardian Trust & Deposit Company vs. Fisher, 200 U. S., p. 57, Brewer, 115; Federal Reporter, 184.

Discussion Before the Technical League on the Blackwell's Island Bridge.

In our issue of Dec. 9, 1908, we printed two of the discussions recently presented before the Technical League on the deficiencies in the Blackwell's Island Bridge found by the experts appointed to report on its safety and efficiency. We give here a third discussion which we believe will be read with even greater interest than were the two others:

DISCUSSION NO. C.

A former commissioner of bridges made plans for two bridges over the East River; one was rejected, but a contract was let for the other. This contract was left as a legacy for the next, and the present administrations. Through incompetence or worse, many startling defects had crept into the contract drawings. The action of the rockers (at panel points 37 and 91) was neglected, startling but true. Even neglecting the rocker, incompleteness played havoc. For instance, for diagonal C70-U71 contract drawing stress for live load +1386, correct static stress +2327, correct stress including rocker +2685; errors of 63 per cent and 93 per cent; for diagonals U61-C62 contract drawing stress +2000, correct static stress +3040, correct stress including rocker +3206; errors of 52 per cent and 60 per cent. These are only samples of errors which occurred, from end to end of the bridge. I believe there was not a single main member calculated correctly. Structural members were subject to alternate tension and compression with a variation of 41,000 lbs. per sq. in. No allowance was made for secondary stresses. There was no wind bracing in the plane of the top chord. Sections of the top chord 83 ft. long had no vertical support between ends. Columns 200 ft. long and only 3 ft. wide, as members U57-L59, L73-U75, had no lateral support. No wind bracing was provided in the bottom chords except through plates already mechanically buckled. Were these buckled plates connected as shown they would be subject to shear from wind, cross bending from the floors, compression from the bottom chord, and compression from the stringers, surely overworked. The torsional effect of the wind on the truss was not shown. The contractor was given the option of using structural or nickel steel, of which he later availed himself. These were a few of the obstacles which the succeeding administration overcame (see their report to the mayor), and the successful erection of the structure redounds to their credit. The chief criticism is that they did not abrogate the contract, pay the contractor, say \$300,000 bonus, and erect an American type of bridge.

Before comparing the two types of bridge, American and European, with regard to economy, esthetics and practicability, I shall state that I have made a design of the former, and compared it to the structure now completed.

Both were designed for the same live loads, and by the same specifications. In the structure now completed, under certain conditions of loading, the unit stresses run 25 per cent higher than the maximum in American design.

The reckless waste of the European design is shown by the following:

Plate 1—American Design.

Maximum moment at point 17= $\frac{1}{10} WL^2$.

Maximum moment at point 57= $\frac{1}{10} WL^2$.

Plate 2—European Design.

Maximum moment at point 17= $\frac{1}{8} WL^2$ + elastic effect of loads ($W \times a + W \times c$).

Maximum moment at point 57= $\frac{1}{8} WL^2$ + elastic effects of loads ($W \times b + W \times d$).

The elastic effect of loads $W \times a$, $W \times b$, $W \times c$, $W \times d$ was omitted on the contract drawings.

The effect of these and other economies (anchorage, etc.) makes the European type almost 81 per cent heavier than the

formed that "congested traffic" meant a load over the entire bridge, or a load caused by a blockade at any point congesting the traffic in one or both directions. This method of assuming the loads was evidently satisfactory to a member of the firm of expert engineers who have written a report; see "transactions of the Brooklyn Engineers' Club," pages 86 and 110.

For these loads the bridge is surely safe. I am told that as an extra precaution before four elevated tracks are run across the bridge, some unnecessary weight in the floor will be removed. In regard to actual weights overrunning assumed weights, I can assure you that even firms which write expert reports are not free from this on city work.

I hope the bridge is examined physically and tested by loading with pig iron to reassure the skeptics.

Remember, gentlemen, a large railroad

LETTERS TO THE EDITORS.

Day Labor Extravagances at Panama and on U. S. Reclamation Service Work.

Sirs:—I rejoice that you have had the courage to bring to the attention of the American people the conditions that obtain at Panama. To those of us who have been so unfortunate as to have been in the employ of the Government, no demonstration, such as yours, was needed. That the cost per yard of material removed is greatly increased by the surveillance and interference of minor clerks at Washington, should, in my opinion, be brought to the attention of the people. The condition of affairs I have in mind is best expressed by a remark I have heard attributed to Mr. Shonts: "I am tired of asking permission to buy a lead pencil." The condition in the Reclamation Service from my personal observation is the same as at Panama, excessive cost of work performed under government engineers only, no contractors; engineers trying to perform the duties of contractors, etc. If you can expose the evils of the present system in this branch of the Government service also, you will render the people another great service.

I enclose my application for membership in the American Society of Engineering-Contractors. With congratulations and best wishes, Very sincerely yours,

CIVIL ENGINEER,

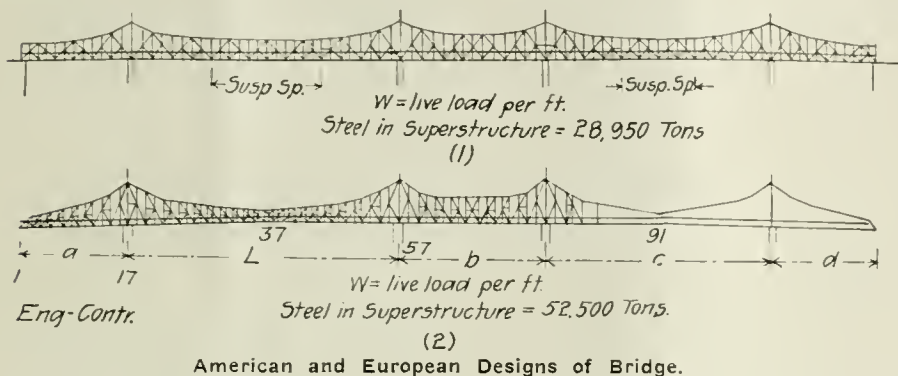
Helena, Mont., Dec. 7, 1908.

City Bureaus of Information for Engineers and Contractors.

Sirs:—I read with a great deal of interest the articles appearing in ENGINEERING-CONTRACTING and will say that they have been highly beneficial to engineers, and especially to those who are seeking information for cost data on engineering construction work. I take the liberty here of making a suggestion to your paper, which if carried out, I believe will be of great benefit to engineers as well as to contractors. It is this:

I believe it would be advisable as well as practicable to establish in the larger cities a bureau of information where an engineer or contractor can readily get information of a general engineering character when he desires it—in other words organize an association of engineers and contractors and let this association employ in each city some young engineer who could be relied upon, and who would undertake the work as a side issue, to furnish information that is desired by engineers and contractors residing in other cities.

I believe there would be no trouble in securing a competent engineer in each city to do this work, and at a reasonable cost. If it can not be arranged for the association to pay this man for his services, let the engineer or contractor who desires the information pay him direct for the information furnished.



American type, and the deflection greater. In regard to the stiffness of the two I will state that in the two river spans the American type has two members which reverse stress, the European has forty members which reverse stresses.

In laying out the American design the speaker sacrificed material to produce a graceful effect. You will note the top chords form a regular curve, in contrast to the sharp lines of the European design.

Note the vertical suspenders (eye bars) as in the suspension type of bridge. The lattice girders in the footwalks and for fascias give a lightening effect to the floor.

For erection the bottom chords of the suspended span, for four panels at each end are made of built-up members.

Stresses in the American type are statically determinate, in the European dependent on the elasticity of the material. In the completed bridge, I am told, it required 30 min. for the point 37 to deflect its proper amount, when point 1 was raised to adjust the rocker at point 37. A proper study of the European design for live load stresses requires about 25,000 calculations, because a load at any one panel affects every main member in the bridge.

The designers and recent investigators differed on account of different interpretations of the specifications. The contractor, evidently in recalculating the stresses for proportioning material, was in-

corporation and a tunnel company would be delighted to see the bridge declared unsafe.

Paris, France, now has three industrial companies engaged in the manufacture of airships. One of these companies, which began operations on Dec. 17, promises to offer the public in four months four large dirigible balloons, each with a 200-hp. motor and room for 15 passengers.

The best daily record for excavation on the Isthmus Canal since the beginning of the canal work by the Americans was made in the Central Division on Nov. 30, when 67,130 cu. yds. of material, car measurement, were taken out by 53 steam shovels. This was an average of 1,256 cu. yds. per shovel.

On Dec. 18 at Le Mans, Wilbur Wright, the American aeroplanist of Dayton, O., established two new world's records for heavier than air machines while trying for the Michelin cup. He remained in the air one hour, fifty-three minutes and 59 seconds. The best previous record is one hour, thirty-one minutes and fifty-one seconds, made by Mr. Wright on Sept. 21. He also broke the record for height flying to a point 350 ft. above the surface of the earth.

Speaking from the City Engineer's standpoint, I receive almost daily communications from engineers and contractors requesting information about this city. These communications are so numerous at times that it is impossible to answer them all, as it requires more time than we can give, and I believe this will apply to all city engineering departments.

I feel assured of the fact that could information be obtained through one of these agencies, the City Engineer would not only be relieved of answering these numerous communications but he could also obtain information himself promptly through this channel. For instance, some time ago I desired to get some information relative to a method of work being done in another city. I presume the City Engineer of that city was busy at the time and could not furnish me the information as promptly as I desired. Had I known of some young engineer of that city whom I could have trusted to get this information, I would have gladly paid him a reasonable fee for his services. I was considerably inconvenienced by the delay in getting this information, and the City Engineer in that city was, no doubt, annoyed by my writing him so many letters asking for a reply.

I would like to see this matter further advocated in your paper, and have your views on the subject. I trust that this suggestion will meet with the approval of other members of the profession.

Very respectfully,

J. W. HOWARD, C. E.

Savannah, Ga., Dec. 10, 1908.

A Proposed Law Restricting the Practice of Engineering and Surveying in Oklahoma.

Sirs:—In the interest of the general engineering field, I am about to draw a proposed bill to be presented to the Oklahoma Legislature, changing the mode of electing County Surveyors to appointment at a salary and creating the office of County Engineer; also to have a State Engineer to have supervision over County Engineers. Applicants for office will stand an examination before the State Engineer and the Board of County Commissioners. The bill will also require engineers in private business to qualify and secure a license before being allowed to pose as "surveyors or engineers."

The state of Oklahoma, like all other states, is infested with men claiming to be engineers and surveyors, who in fact would not make competent chainmen, yet, they get some business and on account of this fact, they are a great detriment to those who try to conduct and apply science to their work as well as correctness.

Realizing the good work you have heretofore done for the general engineering field, I make this request of you, feeling, that you will render me valuable opinions which will materially assist me in this at-

tempt to protect just and competent engineers.

Very truly yours,

DAN W. PATTON,

Civil Engineer and Surveyor.

Poteau, Okla., Dec. 11, 1908.

(We have commented on this letter in our editorial columns.—Editors).

The Value of a Competent Locating Engineer.

Sirs—I have been quite interested in the article in your issue of Nov. 25 relative to staking out curves in rough ground, by Mr. Robert Laird, and while, as he surmises, this method is not by any means new, I think he is correct in saying that a description of this method has not heretofore appeared in print. The reason for this undoubtedly is, as he states, that this method should be perfectly obvious to any man with a good working knowledge of geometry and sufficient ingenuity in his make-up to enable him to properly direct the work of a field party on location.

It is just those qualities of ingenuity and imagination, however, which differentiate the ordinary rule of thumb engineer in charge of a location party from the true locating engineer, or for that matter, the ordinary man in any walk of life from the truly successful man who gets out of the rut. While the promoters of new railroads, and the men putting up the money to finance new projects, however, feel they are being robbed, when they pay a locating engineer \$150 or \$175 a month, they can hardly expect to get a very high quality of brain-work or even experience, although as a matter of fact they often do, and the difference between this salary and that which a really good man should get, is not only lost many times over in the increased cost of the surveys, but a great many more times in the increased cost of their railroad.

Mr. Laird's description is very clearly put and should be of value to all who need it. It is especially valuable in heavily timbered country and the writer has used it to much advantage in some of the tropical forests where the vegetation and undergrowth are very dense. The note as to leaving the stakes on the short semi-tangents, rather than moving them over to the curve, is to be especially commended as a great help to the leveller and topographer. Yours very truly, F. LAIRS,*

M. Am. Soc. C. E.

134 Elm Ave., Mt. Vernon, N. Y., Nov. 30, 1908.

Pennsylvania has 99,041 miles of highways, of which 1,101 miles are privately-owned toll roads.

The Board of Water Supply of New York City has rejected all bids for constructing the Walkill pressure tunnels and is readvertising the work until Jan. 7.

*Author of "Railroad Location Surveys and Estimates."

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 1019. **Handbook for Engineers.**—By George N. Saegmuller. Rausch & Lomb Optical Co., Rochester, N. Y.

This book, of vest pocket size, contains the Solar Ephemeris for 1909 and also directions for using the Saegmuller Solar Attachment. There are directions, with diagrams for using and adjusting the engineer's wye level, the dumpy level and the transit instrument, as well as other useful information. This book is of interest to all engineers and students of engineering. It will be sent at once free of charge upon request.

No. 1020. **Air Compressors for Industrial Service.**—National Brake & Electric Co., Milwaukee, Wis.

This pamphlet illustrates and describes the line of motor and belt operated air compressors built by the above company for industrial service. The illustrations show a very compact looking machine, and all interested in this class of compressed air service should secure this catalog.

No. 1021. **Gas Furnaces.**—American Gas Furnace Co., New York, N. Y.

This 212-page pamphlet covers a very full line of gas generators, pressure blowers, gas-blast furnaces, heating machines, blow pipes and burners, etc.

No. 1022. **Friction Clutches.**—The Hill Clutch Co., Cleveland, O.

This pamphlet describes the Hill friction clutch, gives directions for adjustment, erection and care and a number of useful tables.

No. 1023. **Cableways.**—Lidgerwood Mfg. Co., New York, N. Y.

This large page catalog of 168 pages gives a wealth of suggestive information about the construction and operation of cableways for various purposes. Views are shown of cableways applied to nearly every possible service, and in many cases records of work are given. Contractors should secure this catalog and keep it on file.

No. 1024. **Gas Engines.**—Charles A. Stickney Co., St. Paul, Minn.

This is an excellent descriptive catalog of gas engines. The engine is described in detail and various forms and mounting arrangements are shown.

No. 1025. **Road Machinery.**—J. F. Stroud & Co., Omaha, Neb.

This pamphlet catalogs elevating graders, drag and wheel scrapers, grading plows, dump carts, road machines, road levelers, etc. The various machines are illustrated and briefly described and prices are given.

No. 1026. **Concrete Mixers.**—Keystone Engineering Co., Wilkesbarre, Pa.

A 16-page catalog, gotten up in an artistic manner, telling of the Hodel concrete mixer, manufactured by this company. Each feature of the mixer is described and illustrated, showing wherein it excels others, and that "it certainly is a mixer that mixes." This being the slogan of the Keystone Engineering Co.

Sulphite pitch, according to a recent consular report, is being used with much success in Germany as a dust layer for roads. According to the report, the sulphite pitch is dissolved with water to a certain consistency and sprayed over the roads, such a dressing being sufficient to prevent the dust arising for at least six weeks. Sulphite pitch is obtained in the process of manufacturing sulphite cellulose. The wood is put through a washing process in lye by which the fiber is cleared of all resinous ingredients, it being pressed out from the wood pulp. Through a cooking process it is reduced to a highly glutinous substance called sulphite pitch.

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Dec. 23. Lock Haven, Pa.....	Dec. 16
Dec. 24. Sumner, Wash.....	Dec. 2
Dec. 29. Warsaw, Ind.....	Dec. 23
Dec. 30. Indianapolis, Ind.....	Dec. 23
Jan. 1. Handsboro, Miss.....	Dec. 23
Jan. 1. Newport, Ore.....	Dec. 16
Jan. 2. Grand Island, Neb.....	Dec. 23
Jan. 4. Sandusky, O.....	Dec. 23
Jan. 5. Fairport, N. Y.....	Dec. 16
Jan. 5. Grenada, Miss.....	Dec. 23
Jan. 5. Stockton, Cal.....	Dec. 23
Jan. 6. Granite Falls, Minn.....	Dec. 23
Jan. 7. Aberdeen, S. Dak.....	Dec. 23
Jan. 8. Salt Lake City, Utah.....	Dec. 9
Jan. 8. Cincinnati, O.....	Dec. 23
Jan. 8. Cincinnati, O.....	Dec. 23
Jan. 8. Cincinnati, O.....	Dec. 23
Jan. 11. Newark, O.....	Dec. 23
Jan. 11. Minneapolis, Minn.....	Dec. 23
Jan. 12. Geneva, Neb.....	Dec. 16
Jan. 12. Rensselaer, Ind.....	Dec. 16
Jan. 12. Augusta, Ga.....	Dec. 23
Jan. 13. York, Neb.....	Dec. 23

Buildings.

Dec. 23. Jersey City, N. J.....	Dec. 2
Dec. 23. Porterville, Cal.....	Dec. 9
Dec. 23. Buffalo, N. Y.....	Dec. 16
Dec. 23. Utica, N. Y.....	Dec. 16
Dec. 23. Montreal, Que.....	Dec. 16
Dec. 26. Americus, Ga.....	Nov. 25
Dec. 26. San Jose, Cal.....	Dec. 2
Dec. 26. Regina, Sask.....	Dec. 23
Dec. 28. Lake Charles, La.....	Nov. 25
Dec. 28. Covina, Cal.....	Dec. 9
Dec. 28. Alexandria, La.....	Dec. 16
Dec. 28. New York, N. Y.....	Dec. 23
Dec. 28. New York, N. Y.....	Dec. 23
Dec. 28. Brooklyn, N. Y.....	Dec. 23
Dec. 28. Covington, Ky.....	Dec. 23
Dec. 28. Oakland, Cal.....	Dec. 23
Dec. 29. Alton, Ill.....	Nov. 25
Dec. 29. Columbus, O.....	Dec. 16
Dec. 29. New York, N. Y.....	Dec. 23
Dec. 29. Kansas City, Mo.....	Dec. 23
Dec. 30. Moultrieville, S. C.....	Dec. 9
Dec. 30. Vernon, B. C.....	Dec. 16
Dec. 31. Fort Howard, Md.....	Dec. 9
Jan. 2. Boston, Mass.....	Dec. 23
Jan. 4. Sault Ste. Marie, Mich.....	Nov. 25
Jan. 4. Lisbon, O.....	Dec. 9
Jan. 5. Niles, Mich.....	Nov. 25
Jan. 5. Frankfort, Ky.....	Dec. 9
Jan. 5. New York, N. Y.....	Dec. 23
Jan. 6. Paris, Ill.....	Dec. 9
Jan. 6. Fort Slocom, N. Y.....	Dec. 9
Jan. 6. Fort Meyer, Va.....	Dec. 16
Jan. 7. Johnson City, Tenn.....	Dec. 9
Jan. 8. Stillwater, Okla.....	Dec. 16
Jan. 9. Murfreesboro, Tenn.....	Dec. 9
Jan. 9. Key West, Fla.....	Dec. 23
Jan. 9. Washington, D. C.....	Dec. 23
Jan. 11. Gainesville, Fla.....	Dec. 16
Jan. 12. Warren, O.....	Dec. 16
Jan. 18. Fort Meade, S. Dak.....	Dec. 23
Jan. 20. Springfield, Mass.....	Dec. 23
Jan. 23. Portland, Me.....	Dec. 23

Roads and Streets.

Dec. 23. Cleveland, O.....	Nov. 25
Dec. 23. Roanoke, Va.....	Dec. 9
Dec. 23. Pittsburg, Pa.....	Dec. 9
Dec. 23. Brooklyn, N. Y.....	Dec. 16
Dec. 23. Brooklyn, N. Y.....	Dec. 16
Dec. 23. Harrisburg, Pa.....	Dec. 16
Dec. 28. Anderson, Ind.....	Dec. 2
Dec. 28. Kansas City, Mo.....	Dec. 23

Dec. 29. Canton, Ohio.....	Dec. 23
Dec. 29. Salisbury, Md.....	Dec. 23
Dec. 30. Chambersburg, Pa.....	Dec. 16
Dec. 30. Greensburg, Pa.....	Dec. 16
Dec. 30. Hobart, Okla.....	Dec. 23
Dec. 30. Long Island (L. I.), N. Y.....	Dec. 23
Dec. 30. Brooklyn, N. Y.....	Dec. 23
Dec. 30. Indianapolis, Ind.....	Dec. 23
Dec. 30. Bluffton, Ind.....	Dec. 23
Dec. 31. Kansas City, Mo.....	Dec. 16
Dec. 31. Uniontown, Pa.....	Dec. 16
Dec. 31. Kansas City, Mo.....	Dec. 23
Dec. 31. Kokomo, Ind.....	Dec. 23
Dec. 31. Delphi, Ind.....	Dec. 23
Jan. 1. Humboldt, Tenn.....	Dec. 23
Jan. 2. Griffith, Md.....	Dec. 16
Jan. 4. Mt. Pleasant, Mich.....	Dec. 23
Jan. 4. Williamsport, Ind.....	Dec. 23
Jan. 4. Tipton, Ind.....	Dec. 23
Jan. 4. Terre Haute, Ind.....	Dec. 23
Jan. 4. Rushville, Ind.....	Dec. 23
Jan. 4. Huntington, Ind.....	Dec. 23
Jan. 4. Hartford City.....	Dec. 23
Jan. 4. Greenfield, Ind.....	Dec. 23
Jan. 4. Columbus, Ind.....	Dec. 23
Jan. 5. Washington, Ind.....	Dec. 23
Jan. 5. Wabash, Ind.....	Dec. 23
Jan. 5. Tipton, Ind.....	Dec. 23
Jan. 5. Sullivan, Ind.....	Dec. 23
Jan. 5. Lebanon, Ind.....	Dec. 23
Jan. 5. Covington, Ind.....	Dec. 23
Jan. 5. Brownstown, Ind.....	Dec. 23
Jan. 6. Muncie, Ind.....	Dec. 23
Jan. 6. Madison, Ind.....	Dec. 23
Jan. 12. Rockville, Md.....	Dec. 23
Jan. 14. Flemington, N. J.....	Dec. 23
Jan. 18. Pensacola, Fla.....	Dec. 23
Feb. 1. Olympia, Wash.....	Dec. 23

Sewers.

Dec. 23. Louisville, Ky.....	Dec. 16
Dec. 24. Galveston, Texas.....	Dec. 16
Dec. 27. Fort Wayne, Ind.....	Dec. 16
Dec. 28. Pipestone, Minn.....	Dec. 2
Dec. 28. West Allis, Wis.....	Dec. 16
Dec. 28. Houston, Texas.....	Dec. 23
Dec. 28. Zanesville, O.....	Dec. 23
Dec. 28. Youngstown, O.....	Dec. 23
Dec. 29. Canton, O.....	Dec. 23
Dec. 30. Louisville, Ky.....	Dec. 16
Jan. 6. Winchester, Ind.....	Dec. 23
Jan. 7. Erie, Pa.....	Dec. 16
Jan. 8. Valparaiso, Ind.....	Dec. 23
Jan. 13. Polk, Pa.....	Dec. 23
Jan. 14. Danville, Pa.....	Dec. 23

Water Supply.

Dec. 28. Markdale, Ont.....	Dec. 28
Dec. 29. Pittsburg, Pa.....	Dec. 23
Dec. 31. Oakville, Ont.....	Dec. 23
Jan. 2. Louisville, Ky.....	Dec. 23
Jan. 5. Leesburg, Fla.....	Dec. 23
Jan. 12. Connersville, Ind.....	Dec. 2

Miscellaneous.

Dec. 24. Fort Morgan, Ala.....	Sea Wall, Dec. 2
Dec. 28. Winnipeg, Man.....	Electric Plant, Dec. 9
Dec. 29. More Island, Cal.....	Wharf Work, Dec. 16
Dec. 29. Boston, Mass.....	Subway Work, Dec. 23
Dec. 30. Columbus, O.....	Laying Track, Etc., Dec. 23
Jan. 4. Hartford, Conn.....	Street Lightning, Nov. 18
Jan. 4. Galveston, Texas.....	Metal Work, Dec. 16
Jan. 4. Tenuycape, U. S.....	Breakwater Extension, Dec. 23
Jan. 5. Boston, Mass.....	Refuse Disposal, Dec. 16
Jan. 6. West Union, Ia.....	Celk, Dec. 16
Jan. 7. Kingston, Ont.....	Masonry, Concrete Piles, Etc., Dec. 23
Jan. 7. Portsmouth, O.....	Street Lighting, Dec. 23
Jan. 7. New York, N. Y.....	Pressure Tunnel, Dec. 23
Jan. 15. Ottawa, Ont.....	Steamer, Dec. 2
Feb. 13. Hawaii.....	Dry Dock, Dec. 9

Excavation, Earth and Rock

Dec. 24. Winchester, Ind.....	Ditch Work, Dec. 23
Dec. 26. Adams, O.....	Ditch, Dec. 23
Dec. 29. Burlington, Ia.....	Ditch Work, Dec. 16
Dec. 29. Rockwell City, Ia.....	Drain, Dec. 23
Jan. 2. St. Paul, Minn.....	Ditch Work, Dec. 23
Jan. 6. Houston, Texas.....	Ditch Work, Dec. 23
Jan. 9. Anoka, Minn.....	Ditch Work, Nov. 25

Jan. 9. Houston, Texas.....	Drainage Work, Dec. 16
Jan. 9. Delphia, Ind.....	Drain, Dec. 23
Jan. 15. Mobile, Ala.....	Dredging, Dec. 23
Jan. 15. Mangum, Okla.....	Railroad Grading, Dec. 16

Materials, Machines, Supplies, Tools, Etc

Dec. 23. Kansas City, Mo.....	Pump, Motor, Etc., Dec. 16
Dec. 23. Pittsburg, Pa.....	Refrigerating Plant, Etc., Dec. 23
Dec. 28. Washington, D. C.....	Lumber, Jacks, Etc., Dec. 9
Dec. 28. Camaguey, Cuba.....	Pumping Plant, Dec. 9
Dec. 28. Youngstown, O.....	Water Meters, Dec. 23
Dec. 29. Chicago, Ill.....	Pipe, Dec. 23
Dec. 29. Mare Island, Cal.....	Locomotive Cranes, Dec. 23
Dec. 31. Washington, D. C.....	Powder Hoists, Dec. 2
Jan. 4. Fort Monroe, Va.....	Engines, Boilers, Etc., Dec. 9
Jan. 4. Washington, D. C.....	Steel, Iron, Drills, Etc., Dec. 16
Jan. 15. Portland, Ore.....	Portland Cement, Dec. 2
Jan. 25. North Vancouver, B. C.....	Road Machinery, Dec. 23
Feb. 22. Winnipeg, Man.....	Pump, Motor, Dec. 9

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Stockton, Cal.—Until 10 a. m., Jan. 5, by Supervisors of San Joaquin County, for constructing two steel draw-span bridges, one 90 ft., and the other 249 ft., with 60-ft. approach span and steel tube substructure.

Augusta, Ga.—Until noon, Jan. 12, by Council Committee on Bridges, at office of Mayor Dunbar, for constructing 8-span steel bridge at Center St. Total length is 928½ ft. and estimated cost is \$40,000. Contract for substructure work has already been let. One span is to be pivoted for a draw. Nisbet Wingfield, City Engineer.

Indianapolis, Ind.—Until 10 a. m., Dec. 30, by Albert Sahn, County Auditor, for the following work: Retaining wall along west bank of White River, north of Morris St. bridge; bridge over Fall Creek at Capitol Ave. Indianapolis; bridge over White Lick Creek in Wayne Township.

Warsaw, Ind.—Until Dec. 29, by J. C. Beagle, County Auditor, for constructing bridge at Smith St.

Wichita, Kan.—County Commissioners are reported to be calling for bids for the following bridge work: Two steel bridges, 150 ft. long, to be built over Spring Creek, one in Rockford Township and one in Morton Township; 180-ft. steel bridge to be built in Delano Township over Cowskin Creek. The old steel from the Douglas Ave. bridge is to be used in the construction of a new bridge across the Arkansas River on Lawrence Ave. Also for a bridge to be erected over Chisholm Creek in Wichita Township. The total cost of the bridges will be about \$16,000.

Granite Falls, Minn.—Until Jan. 6, by S. O. Tjosvold, for building steel bridge on a judicial highway.

Minneapolis, Minn.—Until 11 a. m., Jan. 11, by Hugh R. Scott, County Auditor, for repairing bridge.

Grenada, Miss.—Until Jan. 5, by City Clerk, for constructing 1-span 125-ft. iron bridge.

Handsboro, Miss.—Until noon, Jan. 1, by City Clerk, for erecting steel draw bridge over Bayou Bernard.

Grand Island, Neb.—Until noon, Jan. 2, by G. H. Poell, County Clerk, for construction and erection of wooden and metal bridges for county for ensuing year.

York, Neb.—Until Jan. 13, by W. A. Miller, County Clerk, for constructing steel and wooden bridges for York County for ensuing year.

Cincinnati, O.—Until noon, Jan. 8, by County Commissioners, Fred. Drehs, Clerk, for the following county work: Under Specifications No. 741—For reinforced concrete box culvert on Sharon Ave., near Morse Ave., Glendale, Springfield Township.

Cincinnati, O.—Until noon, Jan. 8, by County Commissioners, Fred. Drehs, Clerk, for the following county work: Under Specifications No. 812—Concrete bridge over raceway on Lock St. in Lockland, Sycamore Town-

ship, 144, are also asked for work under Specification No. 119—Construction of a concrete culvert on Salem Pike over Lick Run in Anderson Township.

Cincinnati, O.—Until noon, Jan. 8, by County Commissioners, Fred. Driehs, Clerk, for work under Specifications No. 704—Building west abutment of bridge on Shier Road in Symmes Township.

Newark, O.—Until noon, Jan. 11, by County Commissioners, J. N. Wright, County Auditor, for labor and material necessary to the erection of the superstructure for two bridges: the Taylor Road bridge over the South Fork of the Licking Creek in Union Township, and the Columbia Center bridge on the Columbus Road in Lima Township. J. L. Gilpatrick, County Surveyor.

Sandusky, O.—Until 2 p. m., Jan. 4, by Charles Kubaeh, County Auditor, for new floor system for Hillsburg joint county bridge.

Aberdeen, S. Dak.—Until Jan. 7, by J. C. Daly, County Auditor, for the construction of the following bridges: One 40-ft. span steel bridge between Sections 15 and 23, Township 121, Range 63; one 50-ft. span steel bridge on section line between Sections 19 and 20, Township 122, Range 82; one 60-ft. span steel bridge on section line between Sections 27 and 34, Township 122, range 61; one 150-ft. steel bridge one mile west of Hecka, 16-ft. roadway.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Oakland, Cal.—Until 8 p. m., Dec. 28, by Board of Education, J. W. McClymonds, Secretary, for making alterations to the Lincoln School Building and to the Washington School Building, Galloway & Markwart, Engineers, Balboa Bldg., San Francisco.

Washington, D. C.—Until 11 a. m., Jan. 9, by Bureau Yards and Docks, Navy Department, Washington, D. C., for extensions to galleries at Building No. 102, U. S. Navy Yard, Washington.

Key West, Fla.—Until 11 a. m., Jan. 9, by Bureau Yards and Docks, Navy Department, Washington, D. C., for constructing a concrete and steel storehouse building at the Naval Station, Key West.

Covington, Ky.—Until noon, Dec. 28, by Lyman Walker, Farmers and Traders Bank Bldg., Covington, Architect Board of Education, for various branches of work necessary to complete the new public school building in Austinburg.

Portland, Me.—Until 10 a. m., Jan. 23, by Capt. F. J. Morrow, Constructing Quartermaster, U. S. A., Portland, Me., for constructing, plumbing, heating, electric wiring, etc., of barracks, officers' quarters, non-commissioned officers' quarters, firemen's quarters and a landstand at Forts Williams and McKinley, Maine.

Kansas City, Mo.—Until 11 a. m., Dec. 29, by Samuel A. Boyer, County Clerk, for constructing power house, laundry building, and smoke stack, at the Jackson County Home for the Aged and Infirm (at County Farm, near Little Blue), Smith & Rea, Architects, 722 Dwight Bldg., Kansas City.

Boston, Mass.—Until Jan. 2 (readvertisement), by Special Court House Commission, for enlarging Suffolk County court house.

Springfield, Mass.—Until 3 p. m., Jan. 20, by James Knox Taylor, Supervising Architect, Washington, D. C., for construction, complete, of the extension to the U. S. Post Office and Custom House at Springfield.

Brooklyn, N. Y.—Until 11 a. m., Dec. 28, by C. B. J. Snyder, Superintendent of School Buildings, New York, for repairs, alterations, etc., to a number of public school buildings in the Borough of Brooklyn.

New York, N. Y.—Until 11 a. m., Jan. 5, by Board of Water Supply, 299 Broadway, for constructing three field office buildings, three horse sheds and one stable in the Esopus Division of the Catskill Aqueduct in the towns of Olive and Marbletown, Ulster County.

New York, N. Y.—Until 11 a. m., Dec. 28, by C. B. J. Snyder, Superintendent of School Buildings, for installing electric equipment in new Public School No. 114 on James, Oak and Oliver Sts.

New York, N. Y.—Until 10 a. m., Dec. 29, by Theodore A. Bingham, Police Commissioner, for labor and materials required in making and completing electric light and power installation throughout the Police Department stable, 153 and 155 East 32d St.

New York, N. Y.—Until 10:30 a. m., Dec. 28, by Nicholas J. Hayes, Fire Commissioner, for repairs to heating systems of a number of quarters of fire companies.

Fort Meade, S. Dak.—Until 10 a. m., Jan.

18, by Capt. L. C. Scherer, Constructing Q. M., for constructing hay shed at this post.

Regina, Sask.—Until 1 p. m., Dec. 26, by E. J. Robinson, Deputy Commissioner Department Public Works, for erection of a land titles building, at Saskatoon, Saskatchewan.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Pensacola, Fla.—Until noon, Jan. 18, by Board Public Works, Lee Danell, Chairman, for constructing 634,000 sq. ft. of concrete sidewalks. L. Earle Thornton, City Engineer. Official advertisement will be found elsewhere in this issue.

Bluffton, Ind.—Until 10 a. m., Dec. 30, by O. D. Garrett, County Auditor, for constructing following gravel and macadamized roads: Liberty Township, one road, 5,276 ft. long; Union Township, four roads, 5,293, 1,577, 17,770 and 15,753 ft.; Jefferson Township, five roads, 15,560, 9,680, 15,280, 7,935 and 12,276 ft.; Lancaster Township, two roads, 5,355 and 10,615 ft.; Nottingham and Chester Townships, one road, 10,670 ft.

Brownstown, Ind.—Until 1 p. m., Jan. 5, by H. W. Wacker, County Auditor, for constructing 7,666 ft. of gravel road in Salt Creek Township. Also for 10,712 ft. of gravel road in Jackson Township, and 5,300 ft. of gravel road in Hamilton Township.

Columbus, Ind.—Until 10 a. m., Jan. 4, by John M. Davis, County Auditor, for constructing 13,160 ft. of gravel road in Harrison Township.

Covington, Ind.—Until 1:30 p. m., Jan. 5, by W. B. Gray, County Auditor, for constructing 12,000 ft. of gravel road in Wabash Township.

Delphi, Ind.—Until noon, Dec. 31, by M. G. Haun, County Auditor, for constructing two gravel roads.

Greenfield, Ind.—Until 10 a. m., Jan. 4, by Charles H. Troy, County Auditor, for improvement of public highway in Center Township; also for similar work in Brown Township.

Hartford City, Ind.—Until 2 p. m., Jan. 4, by L. W. Daugherty, County Auditor, for constructing macadam road between Washington and Licking Townships; also for constructing macadam road in Licking Township.

Huntington, Ind.—Until Jan. 4, by B. B. Engle, County Auditor, for improvement of a road in Brown Township.

Indianapolis, Ind.—Until 10 a. m., Dec. 30, by Albert Sahn, County Auditor, for constructing retaining wall and repairs to Three Notch Road in Perry Township.

Kokomo, Ind.—Until 2 p. m., Dec. 31, by Wm. L. Benesn, County Auditor, for constructing gravel road in Liberty and Howard Townships.

Lebanon, Ind.—Until 1 p. m., Jan. 5, by B. F. Herdrich, County Auditor, for constructing a gravel road.

Madison, Ind.—Until 1 p. m., Jan. 6, by G. F. Crozier, County Auditor, for grading, draining and macadamizing 5.6 miles of road in Monroe Township.

Muncie, Ind.—Until 10 a. m., Jan. 6, by Joseph E. Davis, County Auditor, for improving two highways in Delaware Township; also for improvement of two highways in Centre Township.

Rushville, Ind.—Until 2 p. m., Jan. 4, by A. L. Winship, County Auditor, for grading, draining and macadamizing road in Rushville Township.

Sullivan, Ind.—Until noon, Jan. 5, by Ben. C. Crowder, County Auditor, for constructing 4,350 ft. of stone road in Hamilton Township.

Terre Haute, Ind.—Until 11 a. m., Jan. 4, by N. G. Wallace, County Auditor, for improvement of a road in Honey Creek Township.

Tipton, Ind.—Until 2:30 p. m., Jan. 5, by J. P. Barlow, County Auditor, for constructing gravel road.

Tipton, Ind.—Until 10 a. m., Jan. 4, by J. P. Barlow, County Auditor, for constructing 15 gravel roads.

Wabash, Ind.—Until 1:30 p. m., Jan. 5, by J. P. Nefzger, County Auditor, for improvement of four gravel roads.

Washington, Ind.—Until 2 p. m., Jan. 5, by Thos. Nugent, County Auditor, for constructing five gravel roads.

Williamsport, Ind.—Until 1 p. m., Jan. 4, by Robert, L. Winks, County Auditor, for constructing gravel road in Liberty Township. Also for improvement of a road in Pine Township.

Rockville, Md.—Until noon, Jan. 12, by County Commissioners, Robt. G. Hilton, Clerk, for grading and macadamizing about 3¼ miles of road.

Salisbury, Md.—Until noon, Dec. 29, by County Commissioners, Thomas Perry, Clerk, for grading and shell macadamizing about 1½ miles of road. H. M. Clark, Road Engineer.

Mount Pleasant, Mich.—Until 8 p. m., Jan. 4, by Augustus Borden, City Clerk, for paving with asphalt or macadam on Main St. Official advertisement will be found elsewhere in this issue.

Kansas City, Mo.—Until 11 a. m., Dec. 31, by James L. Darnell, City Engineer, for grading on 14th St.

Kansas City, Mo.—Until 3 p. m., Dec. 28, by Park Commissioners, Frank P. Gossard, Secretary, for constructing single curb on both sides of 39th St.

Flemington, N. J.—Until 10 a. m., Jan. 11, by John W. Sharp, Director County Freeholders, for macadamizing 30,979 ft. of road. Grant Davis, County Engineers, White House, N. J.

Brooklyn, N. Y.—Until 11 a. m., Dec. 30, by Bird S. Coler, Borough President, for improvement of a number of streets by regulating and repaving with granite and asphalt.

Long Island City (L. I.), N. Y.—Until Dec. 30, by Lawrence Gresser, Borough President, for constructing sidewalks and for repaving with granite blocks.

Canton, O.—Until noon, Dec. 29, by Board Public Service, C. A. Zellers, Clerk, for paving portion of West 5th and other streets.

Hobart, Okla.—Until 8:30 p. m., Dec. 30, by Jesse Field, City Clerk, for 47,500 sq. yds. of asphalt paving and guttering and curbing. O. E. Noble, City Engineer.

Humboldt, Tenn.—Until 3 p. m., Jan. 1, by N. A. Senter, Mayor, for grading, graveling and guttering streets.

Olympia, Wash.—Until 5 p. m., Feb. 1, by James R. Derer, City Clerk, for constructing about 6,000 sq. yds. vitrified brick or creosoted wood block pavement. Official advertisement. Will be found elsewhere in this issue.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Valparaiso, Ind.—Until Jan. 8, by City Clerk, for constructing sewer.

Winchester, Ind.—Until 7:30 p. m., Jan. 6, by S. D. Fox, City Clerk, for constructing lateral sewer.

Canton, O.—Until Dec. 29, by Board Public Service, C. A. Zellers, Clerk, for constructing several pipe sewers.

Youngstown, O.—Until noon, Dec. 28, by Board Public Service, W. H. McMillin, Clerk, for labor and materials for sewerage Canton St., from Bellevue Ave. to South Ave.

Zanesville, O.—Until noon, Dec. 28, by Board Public Service, J. T. Hahn, Clerk, for labor and material for constructing storm pipe sewers in Ohio, Indiana and Virginia Sts.

Danville, Pa.—Until noon, Jan. 14, by Trustees State Hospital for the Insane, Dr. H. B. Meredith, Superintendent, for constructing sanitary sewer system, consisting of about 7,500 ft. terra cotta pipe sewer, 8 to 15 in.; also for constructing a sewage disposal plant, consisting of concrete sedimentation tanks, sprinkling and sand filters, 12-in. cast iron force main and the electrically-driven and automatically-controlled centrifugal sewage pumps, etc. Albright & Mebus, Engineers, 908 Land Title Bldg., Philadelphia.

Polk, Pa.—Until 2 p. m., Jan. 13, by Trustees State Institution for the Feeble Minded, John A. Wiley, Secretary, for constructing sewage disposal plant. J. A. Murdoch is Superintendent.

Houston, Tex.—Until 4 p. m., Dec. 28, by City Secretary, for connection of South End sewer lift with the sewer. Certified check for \$250 required with bid. H. B. Rice, Mayor.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Leesburg, Fla.—Until 7:30 p. m., Jan. 5, by L. M. Johnson, Town Clerk, for water works and electric light plant. Official advertisement elsewhere in this issue.

Louisville, Ky.—Until Jan. 2, by Board Public Works, for installing 63 fire hydrants.

Pittsburg, Pa.—Until 10 a. m., Dec. 29, by James P. Shaw, Director of Charities and Correction, 511 Fourth Ave., for laying water pipe lines, for fire protection system, at City Home, Marshalsea, P. C., C. & St. L. Ry.

Markdale, Ont.—Until 6 p. m., Dec. 28, by A. Macpherson, Village Clerk, for the construction of the several portions of a municipal water works system as follows: A—Furnishing and delivering cast iron pipe and accessories comprising 2,500 ft. of 8-in. pipe, 2,100 ft. of 6-in. pipe, 10,000 ft. of 4-in. pipe and under. B—Hauling and laying the foregoing. C—Furnishing and laying either stand pipe or elevated tank of about 50,000 gallons capacity. C. H. Mitchell, Engineer, Traders Bank Bldg., Toronto, Ont.

Oakville, Ont.—Until Dec. 31, by A. S. Chisholm, Chairman Board of Water and Light Commissioners, for laying of approximately 1,000 lin. ft. of 8-in. cast iron intake pipe, in Lake Ontario, for the water works system. Pipe and necessary flexible joints will be furnished by the Commission; lead, etc., by the contractor. Willis Chipman, Engineer, Toronto, Ont.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Mobile, Ala.—Dredging.—Until 11 a. m., Jan. 15, by Major H. Jervy, U. S. Engrs., for dredging in harbor at Mobile, Ala.

Delphi, Ind.—Drain.—Until Jan. 9, by J. D. Zartman, Superintendent of Construction, at law office of Hanna & Hall, Delphi, for constructing drain in Jefferson Township.

Rockwell City, Ia.—Drain.—Until Dec. 29, by B. E. Stonebraker, for constructing tile drain.

Winchester, Ind.—Ditch Work.—Until 10:30 a. m., Dec. 24, by A. L. Wright, Commissioner, for material and labor for constructing two drainage ditches.

St. Paul, Minn.—Ditch Work.—Until Jan. 2, S. G. Iverson, Secretary State Drainage Commission, for constructing state ditch at Gun Lake, requiring 332,000 cu. yds. of excavation.

Adams, O.—Ditch.—Until 10 a. m., Dec. 26, by James R. Marker, County Engineer, Greenville, O., for constructing Ditch No. 696 in Adams and Wayne Township. Estimated cost is \$1,121.

Houston, Tex.—Ditch Work.—Until 3 p. m., Jan. 6, by Commissioners of Harris County Drainage District No. 1 at office of George F. Horton, Drainage Engineer, Houston, for the entire work or for any division or section thereof for approximately 350,000 cu. yds. of ditching, depth 4 to 5 ft., base 4 to 20 ft., with 1 to 1 slope.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Boston, Mass.—Subway Work.—Until noon, Dec. 29, by Boston Transit Commission, B. Leighton Beal, Secretary, 15 Beacon St., for enlarging Haymarket Sq. station and subway, and building sub-passageway to the Union-Friend station.

New York, N. Y.—Pressure Tunnel.—Until 11 a. m., Jan. 7 (readvertisement), by Board of Water Supply, Thomas Hassett, Secretary, 299 Broadway, for Contract 36 for the construction of the north half of the Wallkill pressure tunnel, a tunnel in rock crossing under the valley of the Wallkill River, with three shafts 350 to 480 ft. in depth, and a short stretch of plain concrete conduit, known as cut-and-cover aqueduct, and for Contract 37 for the construction of the south half of the Wallkill pressure tunnel, with three shafts 350 to 400 ft. in depth, and a short stretch of plain concrete conduit, known as cut-and-cover aqueduct. The pressure tunnel will be circular, 14½ ft. inside diameter, and the aqueduct 17 ft. high by 17½ ft. wide inside. The work is located in the towns of New Paltz and Gardiner, Ulster County, New York.

Columbus, O.—Laying Track, Etc.—Until Dec. 30, by Board Public Service, E. W. Hirsch, Secretary, for furnishing labor and material for laying and ballasting railroad tracks adjacent to the Scioto River. Contract No. 5, improved garbage disposal. The work consists of laying and ballasting 1,500 lin. ft. of railroad tracks.

Portsmouth, O.—Street Lighting.—Until noon, Jan. 7, by Board Public Service, Martin W. McMahon, Clerk, for the lighting of the streets, alleys and public places with

electricity, gas, gasoline, alcohol or other illuminating medium for a period of three, six or ten years.

Tennycap, N. S.—Breakwater Extension.—Until 4 p. m., Jan. 4, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for construction of an extension to the breakwater at Tennycap, Hants County, N. S.

Kingston, Ont.—Masonry, Concrete Piles, Etc.—Until 4 p. m., Jan. 7, by Nap. Tessier, Secretary Department Public Works, Ottawa, Ont., for the construction of block and mass concrete, dry masonry walls, renewal of old foundation timbers of pile pier and widening of pile pier in front of Royal Military College at Kingston.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Mare Island, Cal.—Locomotive Cranes.—Until Dec. 29, by Bureau Supplies and Accounts, Navy Department, Washington, D. C., for furnishing, under Schedule 657, three steam locomotive cranes for U. S. Naval Station at Mare Island.

Chicago, Ill.—Pipe.—Until 11 a. m., Dec. 29, by Department Public Works, 200 Randolph St., for furnishing and delivering to the city at the city pipe yards approximately 5,590 tons of cast iron water pipe, 6, 8 and 12 in. in diameter.

Youngstown, O.—Water Meters.—Until Dec. 28, by Board Public Service, W. H. McMillin, Clerk, for furnishing 200 water meters.

Pittsburg, Pa.—Refrigerating Plant, Etc.—Until 10:30 a. m., Dec. 23, by Edward G. Lang, Director Department Public Safety, 6th Ave. and Cherry Alley, for furnishing one refrigerating plant complete, for the Bureau of Health; for furnishing three fifth-size double pump steam fire engines; for furnishing one city truck; for furnishing one combination chemical and hose wagon; for furnishing one combination chemical and hose reel, for the Bureau of Fire.

North Vancouver, B. C.—Road Machinery.—Until noon, Jan. 25, by Alex. Philip, Clerk Municipal Council, for road machinery as follows: Compound steam 10-ton road roller, with scarifier attached; hand truck for fuel, oil and tool tender for roller; watering cart with distribution pipe and suction hose; traveling van and two traction wagons of four tons capacity; portable compound toggle knapping motion stonebreaker, with screens, elevating and loading machinery; electric motors, with belt and belt attachments for driving the stonebreaker, etc.; air compressor of sufficient capacity to supply air for driving three pneumatic 2½-in. drills, an air receiver of 34 cu. ft. capacity, with necessary connections and pipes and three 150-ft. lengths of armored ¾-in. hose suitable for the pressure; three Sullivans or Little Giant Rock 2½-in. drills with tripods, weights and complete set of drills each; a Murphy air hammer rock drill, with complete outfit. Specifications, etc., with Donald Cameron, District Engineer.

CONTRACTS LET.

The following contracts have been let recently:

Monrovia, Cal.—Bridge.—California Ornamental Brick Co., Los Angeles, Cal., at \$5,280, for constructing concrete bridge over Santa Ana, work for county.

Denver, Colo.—Viaduct.—Milwaukee Bridge Co., Milwaukee, Wis., at about \$287,430, for the erection of the steel work of the 20th St. viaduct for the city. About 3,900 tons of structural steel will be used, costing \$73.70 per ton. Contract for the hand railing was let to L. Schreiber & Sons Co., Cincinnati, O. This is the contract reported a short time ago as having been let to the American Bridge Co. H. S. Crocker is Engineer in Charge.

Covington, Ga.—Sewers, Water Works.—General Construction & Contracting Co., Atlanta, Ga., for constructing sewer and water systems for which \$60,000 bond issue has been voted. Work will be done under supervision of J. B. McCrary, Consulting Engineer, the material to be purchased by the city.

Atlantic, Ia.—Bridge Work.—S. G. Hunter, for building bridges for county for ensuing year.

Ocala, Ga.—Railroad Work.—R. S. Talmage, Ocala, Ga., for constructing Ocala Southern Ry., from Ocala south to Allapaha, 17 miles.

Fitzgerald, Ga.—Sewer System.—Sullivan & Long, Bessemer, Ala., for constructing

sewer system for this city. J. C. Anderson, City Engineer. Bids were opened Dec. 15.

Jerseyville, Ill.—Pumping Station.—The contract for the construction of the pumping station for the Nutwood Drainage and Levee District in Jersey and Greene Counties, Ill., has been let to the Arbuckle-Ryan Co., Toledo, O.

Pontiac, Ill.—Bridge.—Burnham & Sons, Bloomington, Ill., for erecting new steel bridge over river for Bloomington. Pontiac & Joliet Electric Ry.

Urbana, Ill.—Moving Bridges.—Decatur Bridge Co., Decatur, Ill., at \$358 each, for moving these bridges for this town.

La Fayette, Ind.—Gravel Road.—Monroe Thompson, at \$4,485, for constructing the Bender gravel road in Shelby Township.

Princeton, Ind.—Bridges.—Indiana Bridge Co., Muncie, Ind., at \$14,790, for constructing 26 iron and steel bridges with concrete floors for county; A. P. Eigenmann, Rockport, Ind., at \$6,342, was awarded the contract for seven bridges.

Wichita, Kan.—Bridges.—C. E. Carr, at \$2,025, for 400 ft. pile bridge in Viola Township, at \$1,500 for 300 ft. bridge in Morton Township, and at \$400 for 80 ft. pile bridge in Waco Township, all for the county.

Corbin, Ky.—Railroad Work.—Edington, Griffiths & Co., Knoxville, Tenn., for completing the Madisonville, Hartford & Eastern R. R. This road commences near Corbin, Ky., and is 35 miles long. A large part of the road was constructed prior to October, 1907, when work was shut down.

Louisville, Ky.—Sewer.—Paul & Kershner, Dayton, O., at about \$15,000, for constructing 29th st. sewer. Sewer is to be 2.768 ft. long.

Springfield, Ky.—Bridge.—Champion Bridge Co., Wilmington, O., at \$6,500, for constructing steel bridge over Beech Fork at Fredericktown for the county.

Delphi, Ind.—Gravel Roads, Fill.—Justice & McGreevy, at \$5,100 for constructing Reef gravel road and at \$7,108 for the Kinery gravel road; John M. McGreevy, at 27.9 cts. per cu. yd. for making fill at Camden Arch.

Pulaski, Ind.—Road Work.—Jacob Quigley, Pulaski, at \$5,000 for improvement of road for county. Putnam County—Bridges.—O. O. McDonald, at \$1,200, for constructing two bridges for county.

Clinton, Ind.—Road Work.—Contracts for road work in Clinton County have been let as follows: V. O. Clark, Hillsburg, Ind., for construction of two gravel roads, 15,834 and 10,616 ft. in length, at \$10,010. The Frankfort Construction Co., Frankfort, Ind., for construction of two gravel roads, 12,166 and 15,774 ft., at \$9,300. Giles D. Knapp, Frankfort, Ind., for a gravel road 7,914 ft. in length, at \$3,261. Kelly Bros., Frankfort, Ind., for a gravel road 5,285 ft. in length, at \$1,956.

Muncie, Ind.—Road Work.—Luther Manor, Redkey, Ind., at \$8,212, for constructing two roads for Delaware County; George Saunders, Muncie, Ind., at \$1,300, for improving two highways.

Mount Vernon, Ind.—Road Work.—Contracts for road work in Posey County have been let as follows: Henry C. Eigenmann, Rockport, Ind., at \$11,250, for two highway extensions; Clark C. White, Boonville, Ind., at \$25,800, for three highway extensions.

Huntington, Ind.—Gravel Roads.—Garrett & Brenneman, Bluffton, Ind., at \$12,820, for constructing two gravel roads in Huntington County.

Springfield, Mass.—Dam, Reservoir.—Coleman Bros., 15 Court Sq., Boston, Mass., for construction of Borden Brook Reservoir and dam, Little River Water Supply Contract No. 5. Contract was let Dec. 16 by Water Commissioners, E. E. Lochridge, Chief Engineer, and includes: 10,000 cu. yds. earth excavation, 4,000 cu. yds. rock excavation, 35,000 cu. yds. rolled embankment, 3,000 cu. yds. gravel fill, 3,000 cu. yds. top soil replaced, 1,700 cu. yds. concrete masonry, 8,000 sq. yds. slope paving, 3,000 lin. ft. stone wall, placing c-i. pipe, gates, etc., gate-house and appurtenances, 1,500 lin. ft. macadam roadway, 17,000 lin. ft. common roadway, clearing reservoir site.

Crookston, Minn.—Bridge.—Minneapolis Bridge & Iron Co., Minneapolis, Minn., at \$14,730, for constructing steel bridge to Sampson's addition for city.

Little Falls, Minn.—Bridge.—Hewett Bridge Co., Minneapolis, Minn., at \$4,950, for constructing 140 ft. steel bridge on stone piers over Long Prairie River near Motley for county.

Jackson, Miss.—Postoffice.—H. A. Bishop, 218 La Salle St., Chicago, Ill., at \$40,670, for constructing U. S. Postoffice here.

Kansas City, Mo.—Viaduct.—A. M. Blodgett Construction Co., for steel and concrete

Chicago, Ill.—The Commercial Improvement Association is building a viaduct over the Belt Line tracks at M. in St. The Blodgett Company is now building the approaches under a contract let a month ago.

St. Joseph, Mo.—Street Grading, Sewer. M. Costello, at \$1,162, for grading on Jones St. J. H. Hartman for grading on 26th St. and 19th St., and E. F. Mignery for constructing sewer in District No. 67.

St. Louis, Mo.—School House. Wall Bros., for erecting new Humboldt school at 9th and Sidney Sts.

St. Louis, Mo.—Building Work.—J. W. Wilson & Son, Odd Fellows' Bldg., St. Louis, for the erection of the Soudard Branch Library, to occupy the southwest corner of 7th and Soudard Sts.

Plattsmouth, Neb.—Bridge Work.—Nebraska Construction Co., Lincoln, Neb., for constructing steel bridges for ensuing year for Cass County.

Salem, N. J.—Gravel Road.—J. S. Fisher & Son, Clayton, N. J., at \$10,973, for constructing 3.31 miles of gravel road for county.

Binghamton, N. Y.—Sewer.—John Tyne, at \$1,671, for constructing Ireland Ave. sewer.

Syracuse, N. Y.—Paving.—Long & Haney for constructing tar macadam on Howard St.

Kent, O.—Railroad Work.—Carter Construction Co., Indianapolis, Ind., for track-laying for the Lake Erie & Pittsburg R. R., projected to connect Cleveland and Youngstown by a direct route. Grading has been completed from Mill Creek Junction, near Cleveland, to Kent.

Syracuse, N. Y.—Building Work.—Contracts for remodeling the building in Court St. to be used for a truant school were let as follows: John W. Gee & Son, carpenter work; Fred L. Estrange, mason work; John R. Walsh, plumbing, and Maurice F. Lane, painting.

Dayton, O.—Sewer.—George Hecker, at \$4,151, for constructing storm water sewer in Wyoming St.

Hamilton, O.—Sewers.—Bennett Construction Co., Cincinnati, O., at \$15,765, for constructing Lindenwald storm sewer; J. H. Trunk, Hamilton, at \$2,530, for constructing storm sewer; Garver Construction Co., Hamilton, at \$1,845, for constructing Wayne St. storm sewer.

Mill Creek, Okla.—School House.—M. J. Gill Construction Co., Ardmore, Okla., for \$10,000 brick school building here.

Portland, Ore.—Paving.—Pacific Bridge Co., at \$86,000, for constructing bitulithic pavement on several streets.

Chester, Pa.—Sewer.—John J. Williams & Co., Chester, at \$14,775, for constructing Up-land St. sewer.

Media, Pa.—Sewage Disposal Plant.—Latta & Terry Construction Co., Pennsylvania Bldg., Philadelphia, at \$10,800, for material and labor for constructing sewage disposal plant at Girls' House of Refuge, at Darlington.

Philadelphia, Pa.—Hospital.—Edward Fay & Co., Philadelphia, at \$156,410, for alterations to U. S. Naval Hospital.

Philadelphia, Pa.—Street Lighting.—Welsbach Street Lighting Co., for furnishing and maintaining naphtha lights throughout the city next year.

Columbia, Tenn.—Post Office.—George Moore & Son, for constructing brick and stone post office building here.

Houston, Tex.—Paving.—John C. Underwood, for paving several streets with brick.

Aberdeen, Wash.—Paving.—Andrew Peterson Co., at \$192,791, for paving for this city.

Tacoma, Wash.—Water Mains.—Frank Rice, for laying water mains in Ash St.

Tacoma, Wash.—Road.—F. A. Keasel, at \$1,930, for constructing 1½ miles of road on Fox Island for county.

Green Bay, Wis.—Coal Bridge.—Milwaukee Bridge Co., Milwaukee, Wis., for building new movable bridge for Cargill Coal Co.

of steel, 144 ft. long and 16 ft. wide, and is to have a reinforced concrete floor. Contract is to be let soon.

Cedar Rapids, Ia.—Plans are being made for the new 16th Ave. bridge to be erected by this city. Ira R. Hedrick, Kansas City, Mo., is Engineer.

Sioux City, Ia.—Agreement is stated to have been reached by city officials and various railroad companies interested in the construction of a viaduct over the railroad tracks at Wall St. G. Y. Skeels is City Engineer.

Sterling, Ill.—Joint Bridge Commission in charge of erecting seven steel bridges in Hume Township has been considering plans of State Highway Department, Springfield, Ill., for the work.

Newcastle, Ind.—County Commissioners are to at once call for bids for erection of bridge over Blue River west of this city. Bids have been asked twice before on this work.

Cambridge, Mass.—Cambridge Art Society, C. H. Blackall, Secretary, has received plans for a new bridge on Boylston St., near the entrance to Soldiers' Field. The plans call for a reinforced concrete structure to cost about \$100,000.

Boston, Mass.—State Railroad Commission held hearing Dec. 18 on matter of directing city to repair the Berkeley St. bridge.

Cumberland, Md.—City Council has granted Baltimore & Ohio R. R. permit to improve its viaduct in Cumberland, and work has been commenced under the direction of A. Hunter Griffith, Assistant Engineer of the company. Reinforced concrete will be largely used.

Saginaw, Mich.—Public hearing is to be held Jan. 7 at local Board of Trade Rooms by Lt. Col. C. McD. Townsend, U. S. Engrs., on matter of requiring the Pere Marquette R. R. to make changes in its bridge over the Saginaw River at this city. The changes suggested provide for a single span bascule bridge of 80 ft. clear opening or two draw spans of not less than 80 ft. clear opening each.

Crookston, Minn.—Following bids were received Dec. 7, by City Council, for constructing Sampson's addition bridge: Minneapolis Bridge & Iron Co., \$18,600; Hewett Bridge Co., \$18,200; Hennepin Bridge Co., \$18,690; Canton Bridge Co., \$19,120. For a modified type of construction bids were received as follows: A. Y. Bayne Co., \$14,900; Fargo Bridge & Iron Co., \$13,700; Security Bridge Co., \$17,000.

St. Paul, Minn.—Bill is to come before Congress for the new St. Paul Bridge & Terminal Co. to construct a bridge across the Mississippi River below St. Paul, to afford a short route to the stock yards at South St. Paul.

St. Louis, Mo.—U. S. War Department has approved modified plans of this city for proposed free bridge to be erected over the Mississippi River at or near the foot of Chouteau Ave. Board Local Improvements, A. J. O'Reilly, is in charge of the work.

Asheville, N. C.—County Commissioners are to be petitioned to erect a new bridge over the French Broad to serve West Asheville.

New York, N. Y.—Boller & Hodge, Consulting Engineers, 1 Nassau St., New York, in their preliminary report to the New York and New Jersey Interstate Bridge Commissioners on the construction of a bridge over the Hudson River between New York and New Jersey, favor the erection of the structure at 179th St. The estimated cost of the structure is about \$10,000,000.

Olean, N. Y.—City has voted to build a \$13,000 bridge over the Allegany River at Clark St., and contracts will be let at once. E. E. Allen is City Engineer.

Sandusky, O.—County Commissioners are considering erecting swing bridge over the Huron River at Huron.

Seranton, Pa.—Delaware, Lackawanna & Western Ry., A. E. Deal, Bridge Engineer, Hoboken, N. J., has prepared tentative plans for the erection of a viaduct over Tripp's Crossing in this city.

Dallas, Tex.—County Court is to take steps for raising necessary funds to begin remodeling county bridges over the Trinity River to conform with regulations of U. S. Government. Five bridges are effected and the cost of remodeling these is estimated at \$150,000 to \$200,000. Jack Witt is County Engineer.

Norfolk, Va.—Ordinance is before Board of Aldermen calling for an appropriation of \$9,000 to construct a bulk-head and a bridge over Mahone's Lake Canal, taking the place of the present structure.

Spokane, Wash.—Detailed plans for a reinforced concrete bridge at Monroe St. have been prepared by J. C. Ralston, City Engineer. Estimated cost is about \$325,000.

Milwaukee, Wis.—Resolution is before the City Council directing Charles J. Poetsch, City Engineer, to draw plans and specifications for a viaduct across the Milwaukee River and railroad tracks at Wright and Bradford Sts. The viaduct would cost about \$200,000.

Wheeling, W. Va.—City Council has adopted plans of City Engineer Cooke for the new Market St. bridge and bids for the work will be asked soon. The plans provide for the erection of a truss bridge 162 ft. long and 66 ft. wide. The city will pay \$25,000 and the two traction companies \$15,000 apiece of the cost of the structure.

Railroads.

Items Arranged Alphabetically by States.

Aliceville, Ala.—Meeting was held here recently of the officials and promoters of the Aberdeen & Pensacola Railroad Co. and it is stated that the arrangements were made to secure the necessary capital for completion of the road to some point on the A. T. & N. R. R. H. E. Reynolds is President and George Townsend is Engineer.

Mobile, Ala.—Advices from this city state that a company has been organized to take over the Mobile, Jackson & Kansas City R. R., now in operation between Mobile and Middletown, Tenn., with the view of extending the road to St. Louis, New Orleans and Birmingham. The branch to Birmingham will, it is said, be built from Redfern, Miss., on the main line via Stockville and Columbus. W. F. Owen, Mobile, Ala., is General Manager.

McCreanor, Ark.—C. P. Harnwell, Little Rock, Ark., one of the incorporators of the recently organized Meto Valley R. R. Co., is reported as stating that the construction work on the road will be commenced shortly. As projected, the line is to be built from McCreanor, Ark., to a point about 16 miles south, the object being to open up timber and prairie land. Ultimately, it is said, the road will be extended to Pine Bluff, Ark.

Eureka, Cal.—Northwestern & Pacific R. R., W. C. Edes, Chief Engineer, San Francisco, Cal., contemplates construction of a line through Eureka.

Abbeville, Ga.—The American Ry. Co. has been chartered and proposes to construct a railroad from Abbeville, Ga., to Winchester, via Hawkinsville and Grovania. The right of way from Hawkinsville to Grovania has been given to the company with the understanding that work will begin by March 1. The incorporators of the company include George W. Banneiman, New York City; John E. Lang, S. N. Kreisher, George W. Hood and J. P. Perry.

Walnut, Ia.—Contracts will be let in January for the construction of the Iowa & Omaha Short Line R. R. The projected length is 134 miles and the line is to extend from Omaha, Neb., to Des Moines, Ia. J. H. Mayne, Council Bluffs, Ia., is Chief Engineer.

Fort Wayne, Ind.—City is about to take up the matter of track elevation of the various railroads here.

Topeka, Kan.—Advices from this city quote A. C. Goodwin of the Topeka & Southwestern Railroad Construction Co. as stating that construction work on the Southwestern will be resumed as soon as weather conditions will permit. H. M. Herbert, Trenton, N. J., is President of the construction company.

Munroe, La.—Estimates are being prepared for the construction of the Munroe & Farmerville Northwestern R. R. between Munroe and Farmerville. Capital for construction is reported to have been partly secured. The projected line will be 120 miles long, extending from Munroe to Hope, Ark. Capt. G. H. Nichols, Munroe, La., is interested.

Bay City, Mich.—Bay City & Port Huron R. R. Co., which plans to build a road from Bay City to the Thumb district, has asked the City Council of Bay City for an extension of the franchise for six months. Necessary capital for the construction of the line is said to have been pledged.

Granada, Miss.—Chester H. Pond, of Moorhead, Miss., promoter of the Granada-Pensacola Short Line, is quoted as stating that necessary capital has been raised, surveys completed and actual construction work will be started within six months. The road will be built from Granada to Pensacola, Fla.

Grand Falls, Mont.—Preliminary surveys are under way here for the railway which the Conrad Investment Co. proposes to build to this place.

Livingston, Mont.—Northern Pacific Ry. is securing the right of way for its proposed branch line up the Shields River Valley.

Cassville, Mo.—Cassville & Western Railway, S. M. Mitchell, President, Cassville, Mo., has been having surveys made for the proposed extension to Eureka Springs. The

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States

Fort Smith, Ark.—Residents of this city are urging that pontoon bridge be constructed to connect Fort Smith and Van Buren.

Trinidad, Colo.—County Commissioners have made appropriation for construction of new bridge at Kadrew Siding on the Santa Fe Ry.

Cedar Rapids, Ia.—City is to erect new bridge over Indian Creek. Bridge is to be

extension will include, it is said, the construction of a 1,600-ft. tunnel.

Cleveland, O.—Efforts are being made to end the receivership of the Wheeling-Lake Erie R. R. in order to make necessary improvements. H. T. Douglas, Jr., Cleveland, O., is Chief Engineer.

Lorain, O.—Lorain & West Virginia Ry. has been taken over by Cleveland capitalists, among whom are H. W. Seaman, President, and James Farm-lee, and will, it is said, be extended 30 miles south of Wellington, its present southern terminus, to connect with the Erie & Pennsylvania. An expenditure of \$1,000,000 will be involved. E. Sanderson, Amherst, O., is Superintendent.

Bartlesville, Okla.—Conditional contracts for the construction of St. Louis, Bartlesville & Pacific Ry. are stated to have been given to Jackson-McKernan Construction Co. of New York. The line as proposed is to run from Webb City, Mo., southwest through Bartlesville, Ponca City, Pond Creek, Okla., to an Orient connection.

Mars, Pa.—The Allegheny & Northwestern R. R. Co. has been chartered with capital stock of \$70,000 and proposes to construct a line between Mars and Evans City, 7 miles. John G. McPherson is President and David Gillinger and C. S. Jarvis, all of Philadelphia, are interested.

Pittsburg, Pa.—Advices from this city state that Baltimore & Ohio engineers are working on surveys for the construction of 60 miles of new road to extend from Smithfield, Pa., or Morgantown, W. Va., to Wheeling, along the southeastern border of Pennsylvania. The cost of such a line would be approximately \$4,800,000. D. D. Carothers, Baltimore, Md., is Chief Engineer.

Dragon, Utah.—The Utah R. R., a branch of the Denver & Rio Grande, is planning an extension to cost \$1,750,000 to connect the town of Dragon, Utah, the present northwestern terminus of the road, with Randlett, Utah, 65 miles. N. W. Cooley, Mack, Colo., is General Manager.

Wheeling, W. Va.—Wheeling & Lake Erie R. R. H. T. Douglas, Jr., Chief Engineer, Cleveland, O., is said to be considering extending the North Clairsville-Adena branch to Wheeling.

Grand Rapids, Wis.—Wisconsin Central Ry. Charles N. Kalk, Harvester Bldg., Chicago, Ill., Chief Engineer, is stated to be having surveys made between Grand Rapids and Waukeestau, Wis., for a cut-off on its line between Chicago and Minneapolis, Minn.

Electric Railways.

Items Arranged Alphabetically by States.

Helena, Ark.—J. W. Burks has asked street railway franchise here. It is understood that he will transfer franchise, if granted, to one of several syndicates which are seeking to install a system here.

Modesto, Cal.—Local capitalists have organized a company to build an electrical railway to connect Modesto with the Santa Fe main line at Empire, 5 miles east. It is stated that construction work will begin in a few weeks and that surveys may be extended to Oakdale.

Los Angeles, Cal.—Los Angeles Pacific Co., 16 W. 11th St., Los Angeles, Cal., is to issue a \$15,000,000 bond issue, \$3,000,000 of which will be used for extensions contemplated by the company.

Stockton, Cal.—San Joaquin Valley Electric Ry. has been assured of a franchise at Modesto, thus removing the last obstacle of the proposed interurban line between Stockton and Modesto.

Vallejo, Cal.—Randell, Trowbridge Co., Oakland, Cal., representing eastern capitalists, have applied for a franchise covering the principal streets of this city with the intention of constructing and operating a street railway system.

Denver, Colo.—Charles M. Einfeldt has been granted a right of way for the inclined railway from Montheic road, near Craig Station, to El Dorado Springs. The railway will be built next year and will cost \$100,000. It will be 3,600 feet long and will be operated by cables.

Denver, Colo.—Denver City Tramway Co. has applied for a permit to extend one of its electric lines to Valverde. The company proposes to build a double line 1 1/4 miles long and to complete the work before May. The company is also preparing plans for large shops in Argo to cost \$350,000. J. A. Beeler is General Manager.

Del Norte, Colo.—San Luis Valley Interurban Railway Co. has been incorporated with capital stock of \$500,000. Offices of the company will be at Del Norte and it is proposed to build a road from that place running in an easterly direction to Center, also running from Monte Vista to Center, then to a location of the Devil's Gate Reservoir and from

Center to Sanguache. The directors are John M. Moser, E. L. Fleschman and A. J. Weiss.

Fairburn, Ga.—Construction work is to be started early in January for the proposed electric railway between Fairburn and Atlanta. The necessary \$75,000 to insure construction of the road has been subscribed. The first section to be built will be 10 miles long, extending from Fairburn to College Park. W. T. Roberts, Freeport, Ga., and C. S. Barrett, Union City, Ga., are interested.

Des Moines, Ia.—Capital stock for the proposed Des Moines & Sioux City Interurban Railroad has been increased from \$20,000 to \$50,000. The headquarters of the company moved from Lake City, Ia., to Des Moines. A. O. Anderson, Lake City, is Secretary.

Kankakee, Ill.—Stockholders of the Chicago, Kankakee & Champaign R. R. are considering extending the road from Kankakee to Urbana, Ill. Franchise through nearly all the towns along the proposed route have been selected and it is probable that construction work will be started early in the spring. G. M. Bennett, Urbana, Ill.; William J. West, Loda, Ill., and R. F. Cummings, Clifton, Ill., are directors.

Batavia, Ill.—Aurora, Elgin & Chicago Railroad, Wheaton, Ill., is considering adding the 5th unit to its central power station at Batavia.

Taylorville, Ill.—Taylorville-Nokomis Traction Co. has been chartered with principal office in the city of Taylorville and company proposes to construct an electric railroad from Taylorville via Witt to Nokomis. W. B. Adams, Taylorville, Ill., and Alfred Griffin, Nokomis, Ill., are interested.

Danville, Ill.—Logansport & Wabash Valley Traction Co. is stated to be planning to extend its line from Lafayette, Ind., to Danville, Ill.

Moline, Ill.—Practically all the necessary sum of \$10,000 for the preliminary survey for the proposed interurban line from Watertown to Albany has been raised. The project is being promoted by James Mahan and F. M. Hodges, Davenport, Ia. The People Construction Co. of Davenport, Ia., is interested in the project.

Peoria, Ill.—Surveys of the right of way for the Peoria-Galesburg Interurban Railway are well under way. Charles H. Dunn, Peoria, Ill., is in charge of surveys.

Freeport, Ill.—Freeport Interurban Railway Company has filed its articles of incorporation and proposes to construct an electric railway from Freeport to South Freeport, thence to Polo, Forest Town and Dixon. Owen T. Smith, W. Hance and A. Bidwell of Freeport, Ill., are interested.

Moline, Ill.—Moline, East Moline & Watertown Railroad Co., 16th St. and 2d Ave., Moline, Ill., is to rebuild its 4th Ave. tracks in this city and the company is planning to expend \$500,000 in improvements next year.

Brownstown, Ind.—Special election is to be held in Brownstown and Jackson Township on Jan. 12 to vote for the upon the time of a subsidy for the electric line between Brownstown and Seymour. The subsidy is being asked in the name of the Brownstown Water, Light and Traction Co., which owns the local water and light plant and which will later be merged with another company to construct and operate the line.

Wichita, Kan.—Wichita Railroad & Light Co., South Main St., has been granted permission to construct a line of street railway on Waco Ave. north from 9th St. to city limits.

Lexington, Ky.—Lexington & Interurban Railroad Co., J. F. Pope, Engineer, is said to be planning to spend about \$1,000,000 next year in improving and extending the local lines. A large part of this sum will be spent in building a new power house on Kent River at Valley View and plans for this power house are already under way, so that the work will be advertised in the spring.

Kansas City, Kan.—Necessary capital for the construction and completion of the Kansas City & Kansas Southwestern Ry. Co. is stated to have been secured and it is reported the construction work on the interurban line from Kansas City to the South Kansas gas and oil fields will be started early in the spring. W. Laming, president of the First National Bank of Tonguonoxie, Kans., is president of the railroad company.

Minneapolis, Minn.—Twin City Rapid Transit Co., W. J. Hild, General Manager, 11th St. and Hennepin Ave., will commence work early in the spring on the construction of the new street car line which is to run from Cypress St. on Dayton's Bluff to the State Fair grounds.

Carthage, Mo.—B. J. Daly, Engineer, Springfield, Mo., has completed the first of the three surveys for the proposed Springfield-Carthage Electric R. R.

New York, N. Y.—Queensboro Bridge & Jamaica Co. has been incorporated to operate 20 miles of electric railroad to and from the

new Queensboro bridge at 42d St. and Park Ave. Manhattan & Queensboro Railroad Co. has also been incorporated to operate 3 1/2 miles of line from 11th Ave. and 51st St., New York, to Thompson Ave. and Van Dam St., Long Island City. The principal offices of the company are at 43 Exchange Place, New York.

Brooklyn, N. Y.—Brooklyn Rapid Transit Co. has been granted tenure franchise to extend its trolley line from St. Johns Cemetery to Jamaica.

Pilot Rock, Ore.—Cashier Selegel of the First Bank of Pilot Rock is promoting a project for the construction of an electric railway to connect this town with Nye, Albic, Ustah, Umatilla, Hermiston, Echo and Pendleton.

Tulsa, Okla.—The Western Transportation Co. of St. Paul, Minn., which proposes to build an interurban line from Tulsa to Oklahoma City, has applied to City Council for franchise to build into Tulsa. The route of the line as surveyed a year ago will take it through Supulpa, Okmulgee and several other important towns in eastern Oklahoma.

Banksville, Pa.—Banksville & West End Street Railway Co. of Banksville, Pa., has been chartered and proposes to build a 3-mile line. W. B. Kusen, Pittsburg, Pa., is President. W. P. Heckman, Avalon, Pa., and J. B. C. Miller, Sewickley, Pa., are interested.

Mt. Carmel, Pa.—Mt. Carmel & Locust Cap Transit Co., Mt. Carmel, has been chartered with a capital stock of \$30,000 and proposes to build 2 1/2 miles of line. William Kiefer, Jr., Mt. Carmel, and J. D. McConnel, Ashland, Pa., are interested.

Lebanon, Pa.—Lebanon & Southern Ry. Co., recently organized with a capital stock of \$500,000, has decided to at once have surveys made for 38 miles of track. Jacob M. Schenk, Lebanon, is President. Dr. A. B. Gloninger, Louis Samler and William P. Cadren of Lebanon are the committee in charge of having surveys.

Houston, Tex.—Houston Electric Co., 502 Travers St., proposes to extend its line to the Houston Heights territory at an early date.

Pewaukee, Wis.—Milwaukee Light, Heating & Traction Co. of Milwaukee, Wis., has asked franchise through this village for an electric line. The Milwaukee Western Electric Co. is also asking a franchise here.

Sheboygan, Wis.—Sheboygan Light, Power & Street Railway Company will condemn additional land wanted for right of way through river side for new route of the interurban line through that district.

Sewers.

Items Arranged Alphabetically by States.

Mobile, Ala.—The Mobile Electric Co. has asked franchise to construct a sewer and pipe line to the river and to erect a maintenance and pump house.

Little Rock, Ark.—Ordinance will go before the Council to appropriate \$15,000 for the construction of a storm sewer in Spring St. E. A. Kingsley is Superintendent of Public Works.

Little Rock, Ark.—New sewer district is being organized to serve the section between South 22d and Summit and the Rock Island R. R.

Eureka Springs, Colo.—City sewer commissioners will improve sewer system.

Canon City, Colo.—City has secured right of way over the property of the Rio Grande R. R. for its sewers.

Oroville, Col.—City contemplates putting in new sewer system.

Denver, Colo.—Board of Public Works has established four new storm sewer districts in North Denver and work will be started in the spring. The total estimated cost of the four sewer districts is about \$95,000.

Wallace, Idaho.—City will immediately begin the construction of a system of sewers for which a \$30,000 bond issue has been sold. The first extension is already under way by day labor under the supervision of Street Commissioner Burton.

Indianapolis, Ind.—R. H. Miller, City Engineer, has taken preliminary steps for an investigation of the best method for diverting city sewage from White River.

Taunton, Mass.—Plans for a sewer to connect the State Insane Asylum with the city have been completed.

St. Paul, Minn.—Board of Public Works has reported favorably on the proposed sewer construction costing \$40,000. The largest project is for a sewer in Randolph St. to cost \$35,000.

Carterville, Mo.—City will extend its sewer system.

Missoula, Mont.—City Council has been petitioned to establish a special improvement

diaphragm in order to put in a satisfactory sewer system in the 3d ward.

Winston, N. C.—The West End Sewer Co. has petitioned the County Commissioners for permission to establish a sewer line in West Winston in the Shallow Ford Road.

Albuquerque, N. Mex.—Council sewer committee is considering a proposition of the American Light & Water Co. of Kansas City, Mo., to construct the proposed sewer system for this city on the basis of cost plus 12½ per cent.

Manchester, N. H.—City Council will probably take steps to make special preparation for installing a sewer system in the Amoskeag section of the city.

Batavia, N. Y.—Charles E. Hoppes is making surveys for a new sewer system for this city. Matter will be voted on at the next general election. Kirk B. Mathes is chairman of the sewer committee.

Waverly, N. Y.—New sewage system and sewage disposal plant for this place is proposed. Procter & Potts, New York City, are Engineers.

Canton, O.—City Council is considering construction of a storm water sewer on Liberty St. to cost \$31,000.

Akron, O.—Resolution has been before the Council for the construction of a sewer in Raymond St.

Lorain, O.—Council has passed resolution for the construction of sewers in Spring and Clark Sts.

Springfield, O.—City Engineer is preparing estimates for construction of a sewer in East High St.

Marysville, O.—Mayor Cartmell and City Council have been notified to appear before the State Board of Health in January to show why the city should not be ordered to complete sewer system for disposal plant.

Oklahoma City, Okla.—Plans are under way in the City Engineering Department for improving city sewer system. Estimated cost is \$100,000.

Klamath Falls, Ore.—City is taking steps to install new sewer system.

Meadville, Pa.—Borough will soon ask bids on sewage disposal plant.

Winton, Pa.—Ordinance has been before the Borough Council for the construction of a system of sewers. T. M. Field, Engineer; T. G. Hughes, Secretary of the Borough.

York, Pa.—Ordinance has been before the Council for a vote at the spring election on a loan for the completion of the sewer system. Work will cost about \$425,000. Herling & Fuller, New York City, are Engineers.

Mitchell, S. Dak.—City is considering construction of a storm sewer.

Park City (P. O. Knoxville), Tenn.—Council sewer committee will at once ask bids for constructing sewers. Capt. W. C. Crozer is Engineer.

Denton, Tex.—City is considering installing sewer system.

Arlington, Tex.—City voted Dec. 22 on issuing \$25,000 of bonds for constructing sewers.

Haskell, Tex.—City votes Dec. 31 on issuing \$7,000 of bonds for constructing sewer system. O'Neill Engineering Co., Dallas, Tex., are Engineers.

Seymour, Tex.—City has voted to issue \$12,000 of bonds for sewer construction.

Wenatchee, Wash.—The general plan for sewerage the city is being considered.

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IMPROVEMENTS TO WATER WORKS.

Connersville, Ind.

Notice is hereby given that the City of Connersville, Indiana, will on the 12th day of January, 1909, at 7:30 o'clock p. m., receive proposals for the construction and leasing to said city of certain improvements and additions to the City Water Works and water supply of said city, according to specifications on file in the City Engineer's office.

All proposals to be in the form of an offer to purchase real estate on which to construct pipe lines, pumping station and other things, and to lease all of such property to the city for a term of years, not less than ten (10) nor more than twenty-five (25), at an annual rental to be specified in proposal and providing for the right of said city to purchase said property and water supply at the end of term of years for a fixed price to be therein specified.

Such proposal shall be accompanied by plans and specifications showing style of structure and machinery to be erected specified, together with the contract or lease. The lessor to guarantee the maintenance of the source and supply of water.

Proposals to be accompanied by good bond, payable to said city in the penal sum of one hundred thousand dollars (\$100,000), conditioned that said lessor will complete said additions in accordance with terms of specifications and guarantee the maintenance of said source of water supply during term of lease.

The city reserves the right to hold any or all proposals open to acceptance until one is accepted according to the method prescribed by law.

JACOB S. CLOUDS,
City Clerk.

K. L. HANSON, Engr.

STREET PAVING.

Olympia, Washington.

Bids will be received by the City of Olympia, Wash., until 5 p. m., Feb. 1, 1909, for constructing about 6,000 sq. yds. of vitrified brick or creosoted wood block pavement. Work to begin May 1, 1909.

JAMES R. DERER, City Clerk.

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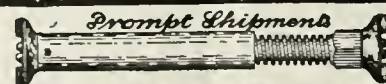
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WATER-WORKS AND ELECTRIC LIGHT FRANCHISE.

Leesburg, Florida.

Bids Wanted.—Town of Leesburg, Fla., invites bids for water works and electric lighting plant. Contract of 5 years given, carrying with it 30-year franchise. Town will pay \$2,000 per year for public service. Bids opened January 5th, 1909, 7:30 p. m.

L. M. JOHNSON, Clerk.

PAVING.

Pensacola, Florida.

Sealed proposals for the construction of concrete sidewalks in the City of Pensacola, Florida, will be received by the Board of Public Works at the City Hall up to 12 o'clock noon of the 18th day of January, A. D. 1909, proposals to be addressed to L. G. Aymard, Clerk of the Board of Public Works, and endorsed "Proposals for Construction of Concrete Sidewalks."

The work contemplated consists of approximately 634,000 square feet of concrete sidewalks. Specifications and blank form of proposal and contract can be obtained from the office of the City Engineer, Room No. 203, City Hall.

The right is reserved to reject any and all bids.

Each proposal is to be accompanied by a certified check for \$500.00, payable to the City of Pensacola.

LEE DANIELL,

Chairman Board of Public Works.

L. EARLE THORNTON, City Engineer.

STREET PAVING.

Mount Pleasant, Michigan.

Sealed proposals for the furnishing of material and the performance of the work necessary for the paving with either paving brick or asphalt macadam, and the construction of cement curb and gutter, on Main Street from the north line of Illinois Street to the south line of Broadway Street, and on Broadway Street from the east line of Washington Street to the west line of Franklin Street, in the City of Mount Pleasant, Michigan, according to the plans and specifications prepared by the City Engineer and now on file in the office of the City Clerk. A copy of said specifications will be furnished on application to City Clerk, that each bid for said pavement, curb and gutter shall be accompanied with a certified check of at least 5 per cent of the bid, as a guarantee that said bidder will enter into a contract and furnish sufficient bonds as required by council in case the contract is awarded said bidder. Said certified check to be made payable to the City Treasurer.

Said proposals to be deposited with the City Clerk of said city on or before Monday, the 4th day of January, 1909, at 8 o'clock p. m., to be opened and publicly read by the Street Committee at that time.

All bidders shall have placed with the City Clerk at the time said bids are to be opened, good and sufficient samples of the respective materials to be used in the construction of said pavement, should their bid be accepted.

Said council reserves the right to reject any and all bids.

AUGUSTUS BORDEN, City Clerk.

STEEL OR CONCRETE BRIDGE.

Salt Lake City, Utah.

Sealed proposals will be received at this office until 8 o'clock p. m., January 8, 1909, for the work of constructing a steel or concrete highway bridge across the Jordan River at North Temple St.

Instructions to bidders, together with specifications and forms for contract and bond, can be obtained upon application at the office of the Board of Public Works or City Engineer.

The right is reserved to reject any and all bids.

By order of the Board of Public Works.

H. J. McMILLAN, Chairman.

LOUIS C. KELSEY, City Engineer.

PROPOSALS FOR CONSTRUCTION OF barracks and quarters, and plumbing and heating and electric wiring same. War Department, office of the Constructing Quartermaster, New London, Conn., November 28, 1908. Sealed proposals for constructing one double barrack, one single barrack, two field officers' quarters, one four-set officers' quarters, two lieutenants' quarters, three double non-commissioned officers' quarters, and one double firemen's quarters, at Fort Terry (Plum Island), New York, and two double barracks, two field officers' quarters, four lieutenants' quarters, two double non-commissioned officers' quarters, and two double firemen's quarters, at Fort H. G. Wright (Fisher's Island), New York, and for plumbing, electric wiring and installing heating plants in same will be received here until 10 a. m., Feb. 10, 1909, and then opened. Proposals are desired for brick construction of all buildings and for reinforced concrete construction on bidders' plans of barracks and non-commissioned officers' and firemen's quarters. Information furnished on application. Envelopes containing proposals should be endorsed: "Proposals for Public Buildings," and addressed: "R. M. Schofield, Major, Q. M., Constructing Quartermaster, New London, Conn."

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Air compressors. See 94.
 2 Asbestos.
 4 Asphalt.
 6 Asphalt plants.
 7 Asphalt tools.
 8 Augurs, pneumatic.
 10 Ballast spreaders.
 12 Ballast unloaders.
 13 Barrows, concrete.
 14 Bearings, ball and roller.
 16 Bearings, self-oiling.
 18 Bellows.
 20 Belt conveyors. See 103
 22 Belt dressing.
 24 Belting, canvas.
 26 Belting, chain.
 28 Belting, leather.
 30 Belting, rubber.
 32 Benders, rail. See 404
 34 Benders, steel reinforcing and.
 36 Blacksmiths' tools.
 38 Blasting latheries.
 40 Block machines, cement and concrete.
 42 Blocks, tackle.
 44 Blowers. See 180.
 46 Blast hole loaders.
 48 Bolts and nuts.
 50 Blue print machines.
 52 Boots, engineers' and contractors'.
 54 Boilers.
 56 Boiler covering.
 58 Bonds, contractors' surety. See 98.
 60 Brakes, air.
 62 Bridge railings.
 64 Brick, building.
 66 Brick, paving.
 68 Brick machines.
 70 Bridges, steel.
 72 Bridges, concrete.
 74 Buckets, clam shell.
 76 Buckets, dump.
 78 Buckets, orange peel.
 80 Brooms, street cleaning.
 82 Caldnets, filling.
 84 Calculating machines.
 86 Cables. See 430.
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 90 Caissons.
 92 Cars, ballast.
 94 Cars, concrete.
 96 Cars, dump.
 98 Cars, flat.
 100 Cars, hand.
 102 Cars, mining.
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 122 Cement testing machines.
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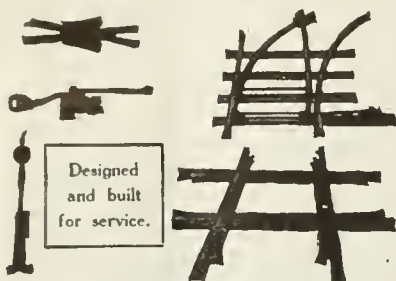
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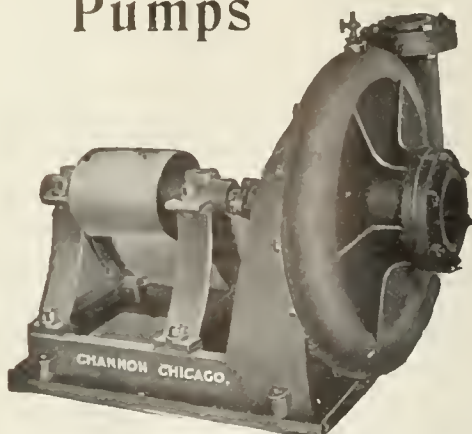
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Maj. Gillette's Defense of the Day Labor Method of Building the Panama Canal, and an Answer.

Elsewhere in this issue of ENGINEERING-CONTRACTING appears a letter from Maj. Cassius E. Gillette defending the day labor system of building the Panama Canal. Maj. Gillette is well acquainted with local

conditions at Panama and his arguments merit earnest consideration.

He contends that the estimated cost of the Panama Canal is not in itself a reliable criterion by which to judge the actual cost, nor do we maintain a contrary view, although we are satisfied that the unit prices used in estimating the cost were liberal enough had the work been done by contract. It is furthermore a fact that the engineers who are responsible for the original estimate did not contemplate doing the work in any other way than by contract, and it would be as manifestly unjust to accuse them of having underestimated the work as it would be unjust to accuse the present canal administration of inefficiency merely because it is unable to do the work within the original estimate.

We base our fundamental argument against the present administration not merely upon the fact that it is exceeding the estimated unit prices by at least 50 per cent. but upon the fact that such an excess invariably occurs wherever a government endeavors to perform extensive construction work by day labor instead of by contract. A year ago we prepared a detailed analysis of the unit cost of excavation on the Canal, and we intend publishing another similar analysis shortly, leaving the figures to speak for themselves as to the actual inefficiency of the day labor method of digging the Canal.

Regarding our criticism of the incompleteness of the cost data as given in the reports of the Isthmian Canal Commission. Maj. Gillette suggests that the Commission may be keeping far better cost records than their reports would indicate. Possibly so, but, if so why do they suppress any of it? We can judge their performance in this respect only by what they report.

Maj. Gillette doubts the value of keeping any very detailed cost records at Panama, for he says: "Anyhow, cost data on this work would have comparatively little value, as we are probably not going to build many more Panama Canals, and as a lamp to guide our footsteps in work outside the tropics, while it would, of course, be interesting and useful, it certainly is not the all important matter in building the Panama Canal."

Maj. Gillette looks upon cost data from the view point of the engineer who uses cost records only to predict future costs. This, however, is the least important function of cost data. The most important function is to furnish an accurate means of measuring the economy with which work is being done. The modern contractor keeps detailed records of cost not merely as a guide in bidding upon future work but to show him where the "leaks" are occurring on his work of today. His unit cost reports of this week are carefully scrutinized to see how they compare with those of last week, and of last month. If one steam shovel outfit is excavating and transporting earth for 12 cts. per cu. yd., and it is costing 16 cts. under another of

his outfits, he wants to know WHY. It is that great big WHY that is ever before his foremen and superintendents which is one of the many stimuli that enable a contractor to do work so much cheaper than a government can do the same sort of work by day labor.

We have just mentioned doing steam shovel work for 12 cts. per cu. yd. including transportation. Perhaps there are many who will infer that the hauls must have been very short—infinitely shorter than on the Panama Canal. But, as a matter of fact, the total cost of loading, hauling, and dumping earth for filling trestles on the Northern Pacific Railway during several years of extensive work, has averaged only 12 cts. per cu. yd. where hauls were as much as 40 miles, and never less than 10 miles. These records, and many more like them in the possession of the writer, form the basis of our criticism of the ridiculously high costs of excavation at Panama.

The average haul from the Culebra Cut on the Panama Canal is 10 miles, yet the following was the cost per cubic yard for the 12,000,000 cu. yds. excavated last year:

Mining	14.47
Loading	11.65
Transporting	19.36
Dumping	14.11
Track	11.52
Division office and supervision.....	1.45

Total (not incl. plant and gen'l items) 72.56

In a subsequent issue we shall have more to say about these figures. Any one of these items alone is sufficient to condemn the day labor method of building the Canal.

Maj. Gillette takes the position that the larger the job the less there is to be gained by doing construction work by contract, which is exactly at variance with our own experience and with that of the great railway companies. A small job can often be handled quite economically by the day labor system, because a new broom sweeps clean. A foreman who is a stranger to the workmen usually gets more work and better work than he does later on when familiarity, or what not, has bred more or less contempt. The large job offers more opportunity to escape the observation of the man at the head, but there is no man so low on the payroll that he does not know who is paying him for his work. Now, who is paying the men at Panama? You and some millions more of us Americans who are several thousand miles away from Panama. We are the owners, and the average man who is working at Panama knows that we are powerless to reward him if he works well or to discharge him if he does not. It is true that we have our "representatives" on the Isthmus to protect our interests; but we have never seen them, nor they, us. All the way down the line, from us who help to foot the bills to him who helps to swell the bills, there is an absence of responsibility that is not found

...the contractor, whether he is large or small. The day labor system is fundamental to the system of Socialism, and it fails to be economic for precisely the same reason—that Socialism fails.

Regarding the matter of sanitation on the Isthmus, it is the province of the Government to preserve the health of its citizens and its employees. Sanitation can be carried on just as effectively where work is done by contract as where it is done by day labor. We have not contended that the sanitation should be left to contractors, except in so far as the letting of contracts for building sewers or doing other construction work incident to the Government's general scheme of sanitation.

We grant that when the Government first took hold of the Panama Canal it would have been premature to award contracts for the excavation. We believe that the Government was wise in doing some excavation work itself. Then every contractor had a measure of the highest possible cost of the excavation. But, after making the test borings, and giving an object lesson as to the character of the excavation, the Government blundered in continuing to make this vast enterprise one grand object lesson in how not to do public work. It blundered, and still blunders, but it is not too late to cease blundering, for two-thirds of the 115,000,000 cu. yds. of excavation remains to be done. The work is really just started.

Maj. Gillette contends that the Panama Railroad could not have been used by different contractors without interfering with one another in transporting the excavated material and supplies. In the handling of supplies, the Panama Railroad should be operated as any railroad is operated, namely by one transportation company. The use of the Panama Railroad for hauling earth and rock was the first big mistake made by the Government. For months and months steam shovels were idle a large part of their time, waiting in the pits for "dirt trams," due to congested condition on the railway. Instead of building a second, or third, or even fourth main track at once, the attempt was made to haul the excavated material over the same line that was hauling freight and supplies. Train crews and shovel crews were idle hours at a time every day. We do not know the precise conditions at present, but the cost of 19 cts. per cu. yd. for transporting excavated materials 10 miles by rail shows that woeeful mismanagement still exists. A contractor would have built adequate rail lines in the first place, and would have cut his transportation costs to a fraction of what it is now costing the Government.

Maj. Gillette suggests that our Dec. 2 editorial may have produced the impression that a sea level canal should have been built instead of a lock canal. It was not our intention to give such an impression. Our opinion is that a wise selection was made in choosing the lock type of canal.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Some Details of Form Construction for the Philadelphia Subway.

The rapid transit railway subway at Philadelphia, Pa., is built for two tracks. It consists of concrete outside walls and a concrete slab roof carried at midspan by a row of steel columns embedded in concrete and set between tracks. The following details of the form construction for the concrete work are given by Mr. S. M. Swaab.* We also give from the same source a brief description of the methods used in bending reinforcing rods. The sewers mentioned, it may be explained, are located just outside the subway walls on each side.

Bending Reinforcing Rods.—As quite large quantities of reinforcing rods were to be used, and as many of them had to be bent to different radii, the question of a power machine for that purpose arose early in the work. No machine was available for bending the twisted rods which were used throughout this work. Ordinary square or round bars could be bent on a tire bender, but the ordinary tire bender would not bend twisted rods; accordingly a machine had to be devised for the purpose.

Another feature of the bars used on the work determined to some extent the design of the machine, i. e., the bars for use in the sewers had to be bent to varying radii, and have a piece of tangent at each end.

The general principle of the machine as built is that of the tire bender. Corrugated case-hardened rolls were used in place of plain ones, as in the ordinary tire bender. The adjustable roll was actuated by a hand wheel operating a rack and pinion determining the position of the roll and, therefore, the radius of curvature. By running this roll entirely out of the plane of the rods while the machine was in motion the rods were passed out of the machine without further bending, thus providing the proper tangent section on the end of the rods. The machine is geared so as to operate rapidly, and is heavily built, and is driven by a link belt by a 1½ H. P. electric motor. The machine will bend any size of rods up to 1 in. square to any radius up to 9 ft. A graduated scale set on the rack indicates when the roll is in the proper position to bend any given radius.

It is not thought at the time that

there would be sufficient cutting of rods to warrant the use of a power cutter, and therefore it was proposed that all of the rods that required cutting would be cut with a hand shear. There was, however, no hand shear on the market that was guaranteed to cut a 1 in. square twisted bar; but a machine without a name plate, evidently built in some small shop for its own use, was obtained and found to work admirably.

Concrete Forms.—The designing of forms for use on this work required that several distinct points be kept in view. They should be:

- (1) Of as simple construction as possible to allow of rapid dismantling or collapsing;
- (2) As compact units as possible to allow of handling under the street surface, and in cramped positions generally;
- (3) As strong as possible to allow of constant re-using;
- (4) As light as possible for facility of handling.

North Carolina pine, fairly free from sap, was used throughout, excepting in some instances where paneling was required, where white pine was used.

Both tongued and grooved and beveled edge stuff was used. The sheeting or lagging for the main walls and slab roof was 2x10-in. plank generally 16 ft. in length, tongued and grooved, and planed both sides. The necessity of accurately centering the tongue and groove where planks are planned both sides is obvious.

The following spacing of uprights was allowed with sheeting or lagging of different thicknesses:

Distance Between Supports.	Commercial Size of Sheeting.
48 on centers.	2 -in.
36 on centers.	1½ -in.
30 on centers.	1 -in.
18 on centers.	¾ -in.

In designing the forms the concrete is assumed to weigh 150 lbs. per cu. ft., and the allowable unit stress in the timber used was taken at 1,000 lbs. per sq. in.

The forms used for encasing the center line columns in concrete were made of 5.1-in. stuff, properly battened. Three sides of this form were made the entire length of the column and hinged together, and the other side was placed as the form was filled with concrete. The fourth side was made in sections of about 3 ft. length, each section being held in position with loose battens, which were supported in

*"Proceedings Engineers Club of Philadelphia," July, 1908, p. 242.

notched pieces set on and protruding beyond the adjacent side. Wooden wedges were used between the loose battens and the sectional front boards of the form to hold them in position. The form itself was held in position in the following manner: The center line columns were built of structural shapes—generally four angles—and several tie plates, arranged so that the web was transverse to the center line of the subway. The forms were set around the steel column on a previously built plinth or base of concrete, and were held at a distance of 1½ in. from the steel on all sides by 40d nails driven through the form on the line of the web of the column, to hold the form from moving in the direction of the longitudinal axis of the subway, the moving of the form in the other direction being prevented by nails driven through the side leaves of the form and just touching the steel angles—the forms, of course, being of such dimensions as to provide the proper amount of concrete to envelop the steel. No bracing of any kind was required to hold these forms in position, other than the nails, which acted to support them, and they were filled at one operation, the forms being removed after 30 hours. The column caps were made of light lagging, each side being battened together and the four sides bolted, so as to admit of easy removal and re-erection.

Crude oil was used for greasing the forms to prevent adhesion of the concrete, and was found to be satisfactory.

The following rules were observed in removing roof forms, subject of course to variation due to the conditions of temperature and moisture, etc.:

Standard roof: leave forms in at least three weeks; load (street car tracks) can be put on in five weeks.

Crossover roof: Leave forms in at least five weeks; load (street-car tracks) can be put on in seven weeks; center posts in crossover can be removed at any time after centers are removed.

Station roof: Leave forms in at least one week; load (street-car tracks) can be put on in two weeks. If it became necessary to load the structure before the expiration of the required time the forms were allowed to remain in place until that time had elapsed.

Upon the initiative of the municipal board the Technical Committee of St. Petersburg, Russia, has elaborated conditions on which it will be allowed to build houses of eight floors, 77 ft. high. Such houses will be allowed to be built on open places, i. e., on squares and quays; neither mansard roofs nor inhabited vaults will be allowed; all interfloor coverings, as well as staircases, shall have to be built of fireproof material. A lift, as well as apparatus for supplying water and fuel in the upper floor will be obligatory.

Cost of Constructing Concrete Piers for a Highway Bridge.

BY HENRY A. YOUNG, C. E.*

The following data were obtained in building the piers for steel bridge No. 1 of the Huntley Project, Montana, one of the U. S. Reclamation Service projects now completed. The bridge was for a 40-ft. span over an irrigating canal, the piers coming in either bank of the canal in such a way that they had to retain an earth fill approach. They were provided with light wing walls. The footings of the main piers were carried down to the level of the bottom of the canal. The tops of the piers reached the level of the original ground surface. The writer does not recall the exact dimensions of the main piers, but they were approximately 20 ft. long, 15 ft. high, 4 ft. wide at the bottom and 18 in. wide on top.

The concrete was figured to take 60 lbs. per sq. in. tension in the back of the wall, and as each pier took two days to build, short steel bars were inserted in the rear of the wall so as to thoroughly bond the first day's work with the second.

All labor was for 10-hour days, but is reduced to equivalent 8-hour days, as required for the Department records.

A Municipal Engineering & Contracting Co.'s ½ cu. yd. cubical mixer was set between the two piers and at one end. Two Ransome carts were used in placing the concrete, each cart holding about half of a mixer load. The mixer was fed by wheelbarrows. The wheel was on a down slope for the first day's work and about level for the following day, when building the upper half of the pier.

The work was done in January and February, 1906, the weather being very cold. This necessitated the heating of the water and sand. The piers were covered at night with canvas and stoves placed around the forms were kept burning all night after concreting. "Salamanders" made out of 5-gallon oil cans with holes punched in the bottom and burning wood were hung inside of the forms when practical.

Water was obtained nearby and the cement had to be hauled only a short distance over level ground. Sand and gravel were hauled from a pit for a quarter of a mile on a down grade. The wheel at the gravel pit was about 30 ft., the material being screened into a bin. The maximum size gravel used was 3 ins. The cost of sand and gravel delivered is recorded in the accompanying table.

The forms were plain and easily built. Lagging was of 2-in. lumber, dressed on one side with the edges beveled to make close joints. Studding was mostly of 2x4 in. stuff. Only one-third of the cost of the lumber is charged to this work, as the lumber was used over several times on later work.

Concrete was placed wet and well spaded.

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Ordinary garden spades, flattened, were used for this purpose. A 1-in. course of 1-2 mortar was placed on the copings of the main piers and wing walls. Chamfer strips were used on all sharp angles.

The excavation was mostly in a dry, sandy clay, though the bottom of the cut was in gravel. The excavation for the canal between the piers, as well as for the piers, was taken out with slips for about half of the depth. Below this the work was by hand. On the land side of the piers the excavation was left at a ¼ to 1 slope.

Water was struck in the last two or three feet, which gave a great deal of trouble, and added considerable to the expense. Pumping was required and finally a coffer dam had to be built around each footing to keep the banks from sliding in while the concrete was being laid. The charge for superintendence is also high, due to the fact that there was little other work going on at this period and the superintendent put in a large part of his time on this excavation.

The work was done by contract, but actual costs are given whether borne by the contractor or by the government. No allowance is made for engineering or general office expenses.

The quantities consisted in the excavation of 133 cu. yds. of earth and gravel and the laying of 120 cu. yds. of plain concrete.

TABLE SHOWING COSTS OF CONCRETE PIERS FOR A HIGHWAY BRIDGE.

Classification— Excavation Class I:		Rate per cu. yd.	
Quantity.	Days.	Rate.	Total.
		\$	\$
Superintendent ..	17½	166.67	97.23
Foreman	26½	50.00	44.18
Laborers	119¼	2.00	238.50
Teams	9½	3.60	33.30
Lumber used in coffer dam, FBM, 1,856		20.25	37.58
coffer dam, ftBM, 1,856		20.25	37.58
Excavating 433 cu. yds. of earth and gravel including coffer dam and pumping		450.79	1.04
Concrete Class I (Plain):			
Superintendent ..	5	166.67	27.78
Superintendence for 130 cu. yds. concrete		27.78	0.214
Forms:			
Boss carpenter...	12½	3.20	49.40
Carpenters	27½	2.80	75.95
Laborers	9	2.00	18.00
Labor on forms for 130 cu. yds. concrete		131.35	1.033
Lumber (1 3 cost). FBM	6,600	6.75	44.55
Nails, kegs.....	2	3.20	6.40
Materials in forms for 130 cu. yds. concrete			
Mixing and placing:		50.95	0.392
Laborers	62	2.00	124.00
Fireman	5¾	2.40	13.80
Teams	8¾	3.60	31.50
Labor mixing and placing 130 cu. yds. concrete.....		169.30	1.302
Sand, cu. yds.....	51	0.66	33.66
Gravel, cu. yds.....	126	0.66	83.16
Cement, bbls.....	153¾	1.86	285.98
Coal, tons.....	3	3.25	9.75
Extra steel, lbs.....	110	0.0288	3.17
Materials for 130 cu. yds. con- crete			
		415.72	3.198
Average cost per cu. yd. of 130 cu. yds. con- crete (plain).....			
			6.139

Specifications for Test Specimens of Concrete to be Immersed in Sea Water by the United States Navy Department.

Considerable attention is being attracted by the comprehensive series of tests on concrete immersed in sea water which are to be made under government supervision at the Navy Yard at Charlestown, Mass. Their extent and thoroughness are indicated by the following specifications which have been drawn for the guidance of the Abertshaw Construction Co., of Boston, through whose co-operation the experiments have been made possible, and for Mr. H. L. Sherman, the cement chemist, also of Boston, who will have direct charge of all tests:

Object.—The object of these tests is to determine what the action of sea water is upon concrete, both as regards climatic conditions and chemical action. The tests are to be made as nearly as possible in conformity with usual commercial work in order to be comparable in all respects with actual work.

How Done.—The specimens are to be built in accordance with the requirements of the Navy Department and under their direct supervision, and in accordance with the following detailed specifications. They are to be built in molds in the sea in such position as may be directed and exposed for easy inspection and for photographing. They shall be so marked as to be easily identified, and a careful record of the materials used and methods shall be kept for each specimen.

Specimens.—The piers shall be 16 ins. square and 16 ft. long, in such a position that the lower 2 ft. shall be permanently immersed in sea water; thus it is improbable that the top will ever be immersed. There are to be 24 piers, as follows: In the first series of 9 specimens, a standard average composition Portland cement shall be used throughout which shall pass the standard specifications of the American Society of Testing Materials as required by the Navy Department.

No. 1. Shall be made 1 part cement, 1 part sand, and 2 parts of stone; mixed quite dry.

No. 2. Shall be made of the same mixture as No. 1; mixed with sufficient water to make the concrete plastic.

No. 3. Same as No. 1 but mixed very wet.

No. 4. Shall approximate 1 part cement, 2 of sand, 4 of stone, but shall be so proportioned after mechanical analysis of materials that the excess of cement over voids of sand shall be 10 per cent, and the excess of mortar over the voids of the stone shall also be 10 per cent. It shall be mixed quite dry.

No. 5. Same proportions as No. 4, but mixed plastic.

No. 6. Same proportions as No. 4, but mixed very wet.

No. 7. 1 part of cement, 3 of sand, and 6 of stone; mixed quite dry.

No. 8. Same as No. 7, but mixed plastic.

No. 9. Same as No. 7, but mixed quite wet.

No. 10. Shall consist of a Portland cement which is free from iron. One specimen shall be mixed of the proportions 1-1-2, quite wet.

No. 11. Same cement as No. 10, 1-3-6, wet.

No. 12. Commercial Portland cement high in alumina, mixed 1-1-2, wet.

No. 13. Same cement as No. 12, 1-3-6, wet.

No. 14. Of a commercial Portland cement low in alumina, 1-1-2, wet.

No. 15. Same cement as No. 14, 1-3-6, wet.

No. 16. Of an iron ore cement practically free from alumina, 1-1-2, wet.

No. 17. Same cement as No. 16, 1-3-6, wet.

No. 18. Of slag cement, 1-1-2, wet.

No. 19. Same cement as No. 18, 1-3-6, wet.

No. 20. Shall consist of the same materials and proportions as given for specimen No. 7, but shall be most thoroughly well mixed (much better than commercial mixing), at the same time being quite wet.

No. 21. Shall be the same as No. 7 except mixed with sea water, quite wet.

No. 22. Shall be mixed of 9/10 by weight of one part of standard Portland cement as No. 7, 1/10 part by weight of hydrated lime, 3 parts sand, 6 of stone, mixed wet.

No. 23 shall be of materials given for No. 7, but in addition shall contain Sylvester mortar hereinafter described, mixed wet.

No. 24 shall be of materials in No. 7, and in addition shall contain 5 per cent by weight of the cement of finely pulverized clay; to be mixed wet.

In addition there shall be 15 cubes, 8 ins. on each side, of 1 part standard Portland cement, 1 part sand, 2 stone; and fifteen others of the same cement, mixed 1-3-6. One-third of these, after being thoroughly wet, shall be permanently immersed in water; another third shall be supported at about half tide; and the rest shall be kept permanently dry, but exposed to the weather.

There shall also be made briquettes of the same cements and proportions of mortar as described for concrete of such number that they can be tested at intervals covering a period of years, some of which shall be kept in the laboratory, some exposed to the same conditions that the cubes will have; and enough briquettes shall be made of standard sand to compare the relative strength between standard and the materials actually used.

Test of Materials.—All cement shall be thoroughly tested for all physical properties and shall be subjected to chemical

analysis. The sand shall be subjected to a thorough mechanical and physical analysis to tell the relative sizes of its grains and the amount of foreign matter which it contains, if any. The same tests shall be applied to the stone. The various ingredients, such as sea water, hydrated lime, Sylvester mortar, and clay, shall be tested that the exact nature of the material may be known.

Sand.—The sand shall be of good quality, commercial bank sand, clean, coarse and sharp, as free from all impurities and foreign matter as can be obtained commercially. The stone shall be of trap rock which shall have passed a 2-in. ring and have been retained on a ½-in. ring. It shall be as free from dust and dirt as commercially practicable.

Mixtures.—All materials shall be proportioned by volume as given above for each specimen. A cubic foot of cement shall contain 100 lbs. by weight. The sand and stone shall be measured on the basis that a barrel of cement contains 320 lbs. net, and measures 3.8 cu. ft. Samples of the sand and stone shall be weighed so that the proportion by weight (as well as by volume) will be known.

The amount of water to be used shall be accurately measured for each batch, and shall be so proportioned by experiment that the dry specimens shall just fail to show moisture when tamped in place; the plastic specimens shall just barely begin to quake when tamped; and the wet specimens shall be so proportioned that the mortar will flow easily off the blade of a shovel and shall be wet enough to flow readily into place without being spaded or tamped.

The Sylvester mortar shall be mixed as follows, as given in Gillett's "Hand Book of Cost Data," pages 389 and following: A light colored soft soap shall be dissolved in water, 1¼ lbs. to 15 gallons of water, 3 lbs. of powdered alum shall be mixed with each bag of cement. After all the materials of the concrete are thoroughly mixed dry, water containing the soap in solution shall be used to mix the materials wet to the proper consistency.

Mixing.—All materials shall be thoroughly mixed in a batch concrete mixer of approved type. They shall be fed into the machine as quickly as possible and shall remain for two minutes after the last ingredient is added. For the specimen that is to be extra thoroughly well mixed the material shall remain in the mixer for 12 minutes.

If the weather be cold, all frost shall be removed from the sand and stone by heating before the materials are placed in the mixer.

Placing.—The concrete after mixing shall be placed in the forms as quickly and continuously as possible, and after proper tamping shall not be again disturbed. In no case shall concrete which has been allowed to stand for more than one-half hour be used, and in no case shall a half

hour elapse between placing two batches of concrete in the same mold.

Forms.—They shall consist of planed and matched spruce lumber, so that the forms may be as tight as possible, and shall be so thoroughly braced as not to spring under the pressure of green concrete. The forms shall be left on for such a length of time that there shall be no damage to the concrete when they are removed. The inspector shall be judge as to when it is proper to remove forms.

Reinforcement.—Columns shall be reinforced with embedded steel bar about $\frac{5}{8}$ -in. square, which shall be bent into a U-shape and run throughout the length of the big specimens, near two diagonally opposite corners and the loop shall project a sufficient distance above the top of columns to permit of their being easily hooked in case it is desired to remove them.

A hole 3 ins. in diameter shall be cored in the upper 8 ft. of each specimen to permit of examination from time to time to see if water has penetrated through the walls of the concrete to the hole.

Protection.—After the specimens are cast they shall be protected as far as possible from freezing until they have set for a period of at least five days, and after the forms have been removed they shall be thoroughly and substantially braced so there shall be no longer danger of their tipping over.

The six track shifting machines in the Central Division, of the Isthmian Canal, moved a total of 333,378 ft., or 129.2 miles of track during November, states the Canal Record. In the Tabernilla district track shifter No. 5 moved 95,100 ft., or 36.9 miles, and No. 6 moved 37,735 ft., or 14.6 miles, a total for the district of 132,835 ft., or 51.5 miles. In the Gorgona district No. 7 moved 74,900 ft., or 29.1 miles and No. 1 moved 11,985 ft., or 4.6 miles, a total of 86,883 ft., or 33.7 miles. In the Pedro Miguel district track shifter No. 9 moved 56,954 ft., or 22.1 miles, and No. 2 moved 56,706 ft., or 21.9 miles, a total of 113,660 ft., or 44 miles.

The seven Lidgerwood unloaders in the Central Division of the Isthmian Canal, during the month of November unloaded a total of 1,666 trains, composed of a total of 28,475 cars. Of this number, 574 trains composed of 10,311 cars, were unloaded by the three unloaders at the La Boca dump, and 1,092 trains, composed of 18,164 cars were unloaded by the four unloaders at Tabernilla. As all the cars were of 20-yard capacity, the material unloaded represented about 569,500 cu. yds.

An American company has obtained a concession in Honduras for the construction of a railway from Truxillo on the Atlantic to Tegucigalpa capital. The company, which has a capital stock of \$10,000,000 has been incorporated in Arizona. Construction work will be started at Truxillo.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Comments on Handling Earth with Wheelbarrows.

Wheelbarrows are adapted to many kinds of work, but their economic use is limited to narrow confined places and to short hauls.

There are many styles of barrows made, each differing in some detail, being made to be used for different work. Those used on earth work are of the tray pattern. The frame work is wood, the wheels are made of steel or wood and vary from 15 to 21 ins. in diameter. Naturally, the larger the wheel the easier it is to propel the barrow, but with the large wheel the barrow sets too high from the ground for economic loading. For most purposes, the steel wheel is to be preferred, for it is made stronger than the wooden wheel, and it will generally outlast the other parts of the barrow but on the other hand in case of accident the wooden wheel can be repaired much easier than the steel one. The trays are made either of wood or steel. When only earth is being handled the steel trays are to be preferred, as the trays do not sift the dirt over the runways, and the dirt dumps easier, especially if it is wet. When there is much rock in the excavation the wooden trays give better service, and are more economical.

It is true that the steel trays will not get out of order and need repairing quite as soon as the wooden trays, but the slight difference is not enough to justify the extra cost, while the steel tray cannot be readily repaired, the wooden tray can be by a blacksmith. Extra steel trays can be purchased to put on the old running gear, or frame, but this is expensive, and the steel trays likewise become dented and bent over the wheel, making it very hard to push the wheelbarrow. The wooden trays holding their shape better, makes them superior for rock work. Several manufacturers are now making what is known as a "stave tray barrow." This barrow tray instead of being made of 3 pieces as the ordinary wooden tray is, is made up of 9 staves. Such a barrow can be recommended for it is easily repaired. The writer has used oil barrel staves to make a new body or to repair old bodies on wooden barrows, and the stave tray barrow can be repaired in like manner.

All steel tubular barrows are made, the entire barrow and running gear being of steel, but the objection to them is that they are too heavy and are also too expensive for earth excavation. Such barrows weigh from 70 to 125 lbs. a piece; while steel trays on wooden frame or run-

ning gear weigh from 55 to 70 lbs., and the wooden tray barrow weighs from 40 to 60 lbs. For contractor's purposes, cheap wheelbarrows should not be bought, as they quickly go to pieces under the treatment they receive. Steel tray barrows weighing less than the above given weights are made, but the trays are of such light steel that it does not pay to buy them. For excavation purposes only the best made barrow should be purchased.

Barrows used for earth work are listed by manufacturers at from 3 to 6 cu. ft. capacity, the ordinary barrow being either of 4 or 5 cu. ft. capacity. It is needless to say that barrows will not carry such loads of loosened earth. Trantune considers a barrow load as 1-14 cu. yd. Specht gives a wheelbarrow load on some levee work as 1-7 cu. yd. Prelini assumes 1-9 cu. yd. as a load. The writer from records kept finds that a barrow load in earth excavation is 1-15 cu. yd. for average earth, clay or moist sand, but in the dry sand a load is only 1-20 cu. yd. The load of 1-15 cu. yd. is confirmed by others, see Gillespie, and Cole's records kept on the Erie Canal. Specht's load is certainly too large, especially going up an incline with a 7-ft. rise, about 200 ft. long. It would be an exceptionable man who could push a load of more than 350 lbs. for an entire day. The load given of 1-15 cu. yd. is for a level haul, on a down hill haul such a load would be slightly increased, and in going up an incline, a little less is hauled, however a load of 1-15 cu. yd. is the average.

Runways of the same kind should always be used for wheelbarrows. The common practice for level short hauls is to lay 1-in. planks on the ground with their ends butting together. Where one man only has to wheel a barrow over the runway, and the planks are changed frequently, such a runway is economical and answers the purpose very well, but when a number of barrows are to go over the runway the ends of the boards should be nailed to a small sill sunk into the ground, so as to prevent the boards from being knocked out of place. Good runways quickly pay for themselves, as to delay a long line of barrows only a few minutes, to straighten out or repair a runway, means to waste considerable money. Where runways are not laid directly on the ground, but are elevated, 2-in. plans should be used, and the runway should be at least 24 ins. wide. They should be substantially built so as there is no motion or swaying to them, as the men wheel over them, or else the barrow pushers will slacken their pace, this is especially true when going on an incline.

steep incline that on short men go up easily, but long incline though not so steep it is not so, men push their barrow up slowly. In either case a strongly built runway is needed. To obtain good work men must be made to believe they are safe from injury while working.

Even grades on runways, if not too steep are an aid in barrow work, but up grades are an impediment. If the incline on the up grade is both long and steep, and if much material has to be handled, some other method should be used. If the amount of material to be handled is small it may pay to use wheelbarrows instead of installing some kind of hoisting machinery. Under such circumstances a rope attached to the front of the barrow and pulled from on top of the runway by either a man or a horse will be found a great help in carrying the load up the incline. If a horse is used a dead man or snubbing post can be used at the top of the slope, to hold two blocks through which the rope should run. A much heavier and larger capacity barrow can be used with a horse. This method cannot be recommended when other modes of doing the work are available. In constructing buildings, hoists or elevators for raising building materials, are often used. Such hoists can be installed at an early stage of the work, and can be used in raising loaded wheelbarrows of earth to the street level, in handling excavated material from footings and other small foundation work, that cannot readily be done when the main cellar excavating is made. The writer has found this much cheaper than going up runways.

When men follow one another in pushing wheelbarrows on the same runway, the load should be dumped from the side of the barrow, but if a man is going back and forth on a runway by himself the dirt should be dumped over the wheel by giving the handles an upward swing. When the dirt is dumped the barrow is dropped onto the ground, the man turning around and pulling the barrow back to the loading place. In this manner the barrow is handled without being turned, and much time is saved, the barrow being pushed when loaded and pulled, when empty. This puts the barrow in the proper position to load, and saves turning the barrow twice.

The customary way of using barrows is for the man who loads it to wheel it. In many cases this is the most economical method, as less time is lost, but there are times that more material can be moved with one man loading and another wheeling, but then two or more wheelbarrows must be used and the runways must be so arranged that time will not be lost in changing from one barrow to another. The man loading the barrow could never be made to loosen the earth, this should be done either with a plow or by other men with picks, as in this way only can the barrow be kept at work the maximum amount of time.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

The Selection of Dust Preventives.*

BY PREVOST HUBBARD,†

It is undoubtedly true that thousands of dollars are wasted annually in a repetition of experiments which have time and again proved costly mistakes. On the other hand, experiments which have given good results in some places have also proved failures when tried in different localities. It is necessary, therefore, not only that the experience of others be considered, but that some thought be given to the probable effect of local conditions upon the results which have in general been obtained. The importance of ascertaining the composition and quality of the material employed has already been dwelt upon at some length in considering the different preventives. While these are most important points, they are by no means the only ones to be taken into account. Differences in composition and physical qualities will often explain the fact that under otherwise similar conditions both good and bad results have been obtained. Discrepancies in results, however, are often obtained under varying conditions, when the same material is employed in each case. The same may be said of the method of application, and narrowing the subject down in this manner we must eventually come to the conclusion that differences in local conditions over which the experimenter has no control are factors of too much importance to be disregarded. Great differences in conditions have, of course, generally been considered, but it is not always those clearly apparent that cause the greatest variance in the results.

Owing to lack of sufficient data by experimenters it is often a hard matter to correlate the results obtained to their actual causes, but upon reviewing the literature of this subject certain facts are indicated which if properly considered should be of some value to the experimenter who has not already learned by experience what material is best suited to the roads he has occasion to treat. It is the author's purpose here to present these facts in such form as to serve as a general guide to the selection of proper material, but it should be understood that they are intended as a guide only and in no sense are to be considered as hard and fast rules. In many instances the selection of a dust preventive may be influenced by a combination of conditions which would be impossible to fore-

see except in individual cases. Sometimes a choice of preventives may seem to be equally divided among a number of materials and experiment alone will determine which, if any, is the most suitable. In many cases the experimenter is handicapped by lack of funds so that the most suitable material cannot always be obtained. In these cases a less suitable material will have to be employed, although in the long run this will often prove more costly. Except in rare instances economy is the most important point to be considered and while permanency of results is often synonymous with economy it is not always so.

The division of dust preventives into two classes, the permanent and the temporary binders, suggests in a general way the first point that should be considered is regard to selection. Taken in connection with the three great classes of roads—country, suburban, and city—it is at once evident that under ordinary conditions the permanent binders only are suited to the first of these for the reason that it is impracticable to treat long stretches of country road at comparatively short intervals of time. When employing temporary binders the road should not only be under constant observation so that applications may be made whenever necessary, but facilities should be such that the work may be quickly and efficiently performed. It is seldom that this condition of affairs exists on a country road. With respect to suburban and city roads and streets, however, no such restrictions exist in the majority of cases, and either class of binder may be employed.

Choice of Materials for Treating Country Roads.—Country roads may be divided into two general classes, hard and soft roads. The first class is represented by the macadam and other broken-stone roads and the latter by earth roads. Sand and gravel roads may also be included in the latter class, although in many cases they more nearly approach the broken-stone roads in point of hardness. Among the permanent dust preventives coal tar and the asphaltic or semi-asphaltic oils are the only ones which can be used under ordinary conditions on account of expense. In the case of hard roads a choice of these two materials will exist, but in treating soft roads oils only have so far proved successful, and except for purely experimental purposes we are limited to this class of material.

The choice between oil and tar for use on a rural macadam road will depend upon several conditions. The first of these would

*From a bulletin of the U. S. Office of Public Roads.

†Assistant Chemist, U. S. Office of Public Roads.

ordinarily be the relative cost at the given location. Other factors, such as relative quality of the available materials, climatic conditions, condition of the road, character of the road metal, and amount and quality of traffic to which the road is subjected, should also be taken into account, and the method of application with reference to these conditions should be carefully considered. In view of the fact that most work of this kind has not been planned or carried on with sufficient forethought, a hypothetical example may be considered even at risk of entering into too much detail. The necessity of clearly illustrating this matter has been made evident to the writer not only from reviewing published descriptions of experiments, but from actual work along these lines.

For example, let us suppose that we have a stretch of rural macadam to treat for excessive dust. Our first effort should be to determine, if possible, any predominant cause for the excessive dust formation. Upon investigation we might find that the road material showed no cementing value, and if the road was exposed to but little motor traffic, a top dressing of some road stone with good binding quality might solve the problem satisfactorily. On the other hand, if motor traffic were heavy we should have to resort to the use of tar or oil, as no such stone road has so far proved able to withstand successfully the action of heavy mixed traffic. With regard to a choice of these materials we should first ascertain which is most easily available at reasonable cost. If a tar produced at a low temperature and containing a fair amount of good pitch base can be obtained, it might be chosen tentatively. If not, a good refined preparation might be purchased. In some localities an asphaltic or semi-asphaltic oil might be more readily available, or a residual oil preparation, but in any event we should ascertain so far as possible the particular properties of the materials which we are considering and unconditionally reject those which for reasons that have already been discussed are almost sure to prove unsatisfactory. Thus a tar produced at high temperature, a paraffin petroleum, or a badly cracked residuum should be at once discarded, no matter how cheap or readily available it might be.

If climatic conditions were such that a surface application would be unlikely to last throughout the winter, and we were unable to rebuild the road so as to make it a bituminous macadam, it would prove most economical to apply only sufficient material to last through the dusty season. In this case a cold application of coal tar diluted with sufficient water-gas or oil to give it the proper fluidity might be made, or a crude semi-asphaltic petroleum used in preference to a more expensive residuum. In climates where a long succession of alternate frosts and thaws occur throughout the winter accompanied by cold rains, a

treatment of this sort will prove far less expensive than a surface application of heavier binding material. Under more favorable conditions, however, this would not be true, and applications of tar or oil requiring heat might be more economical. The condition of the road will often indicate the method of treatment and kind of material which should be employed. If the road is in fairly good condition a surface application is often all that is required. It should, however, be remembered that the function of a permanent binder is not to make a bad surface good, but to keep a good surface in good condition and where the road is badly torn up and raveled it will often prove better policy in the long run to reconstruct it with the addition of a bituminous matrix or else to resurface it with a heavy coat of bitumen-covered stone. In a case of this sort a good coal tar reinforced with pitch is to be preferred unless a very heavy asphaltic oil can be secured. If either material can be obtained the character of the road metal may lead to decision in favor of one or the other. A hard but somewhat porous rock is to be preferred in either case, but perhaps more particularly in that of tar, which is less easily absorbed than oil.

The selection of dust preventives for a soft country road is somewhat restricted, owing to the fact that oil only can be employed. For the softer roads an oil containing even a relatively small amount of paraffin base is valueless as a permanent binder, and we are thus narrowed down to a choice between the exceptionally good semi-asphaltic oils, the true asphaltic oils, and the residuums obtained from each. The oil containing the greatest amount of asphaltic base is usually to be preferred, although this is not always true. In the case of ordinary clay or loam roads the presence of a greater amount of true oil is necessary than in that of sand and gravel roads, in order to prevent the surface from becoming powdery under the action of traffic. Badly cracked residuums should be avoided, even to the extent of using in preference a crude oil containing less asphaltic base. A very clayey soil should be modified by the addition of sand before treatment, and, as has been noted, measures should be taken to overcome the effect of alkali soils upon the oil used. Methods of application suitable to various conditions have been discussed elsewhere and need not be considered here. Where gravel roads are to be treated it is not always necessary to employ an extremely heavy asphaltic oil, although such a material is to be preferred. Where fairly heavy crude semi-asphaltic or residual oils can be obtained at a low figure they may often be used to advantage. And while the results may not be quite so permanent, the reduction in cost as compared with the true asphaltic oils will, under present conditions, more than compensate this difference, especially in the Eastern States.

Choice of Materials for Treatment of Suburban Roads.—There is a wider selection of dust preventives possible in the treatment of suburban roads. Here all types of permanent and temporary binders may compete, and it is often a difficult matter to choose the best material. As most of the conditions governing the selection of permanent binders have already been mentioned, it is only necessary here to consider conditions influencing the selection of temporary binders, should a choice in their favor be made over permanent binders.

If a system of hydrants be located at convenient distances along the road, salt solutions or emulsions can be most easily employed; if not, recourse must be had to one of the lighter oil or tar products. In the latter case that product which contains the greatest amount of binding base per unit cost should be selected, unless it possesses other qualities which are particularly undesirable, such as a strong and disagreeable odor. If an emulsion or salt solution can be employed the character of the road material may be determined which is the most suitable. Thus a hard road, on which the products of wear will be slight provided they are retained upon the surface, or one in which the cementing value of the rock dust is good, can be effectively treated with a solution of some salt, such as calcium chloride. Also, in cases where the climate is more or less humid, a deliquescent salt may give the most satisfactory results. When the climate is very arid, however, the salt will have to be fed with too many applications of water to make its use economical. In the case of a road built of very soft rock, which wears badly under traffic, the asphaltic oil emulsions or the heavy tar emulsions are to be preferred on account of the binding and road-building qualities which they possess. As a general rule, when it is particularly desirable to obtain a road-building emulsion, one containing a volatile saponifying agent might be selected in preference to the non-volatile saponifiers, especially in the case of an asphaltic oil product, where the binding base is apt to be permanently injured by the presence of fixed alkalies. The choice of other emulsions and light preparations will, in many cases, depend upon locality. Where waste products of a deliquescent or binding character can be obtained cheaply they may be utilized for the purpose of dust laying.

In cities and towns where the traffic is heavy and of a mixed character the heaviest permanent binders represented by solid preparations should undoubtedly be used, but unless their use is supplemented by the temporary binders dust prevention is almost an impossibility. This is to a great extent due to the fact that large quantities of dust from outside sources are brought upon the streets, which makes it necessary to apply a dust preventive at frequent intervals. As the permanent liquid binders

oil emulsion cannot be applied in the summer for various reasons, recourse must be had to the temporary binders. The selection of solid preparations for construction purposes comes under the subject of pavements, and has been so exhaustively treated in numerous publications that it need not be discussed here.

Treatment of Park Roads.—Before leaving the subject of selection, the treatment of city park roads should be considered briefly. Here, under ordinary circumstances, we have conditions somewhat different from those pertaining to any of the three classes of roads so far considered. In the first place, park roads are almost entirely given over to pleasure traffic. As they are subjected to little or no heavy teaming, they are usually of lighter construction than the ordinary road, and in many cases are composed of rather soft material. Motor traffic is likely to be excessive, and some suitable dust preventive is often needed.

Permanent binders may be used to advantage in many cases, but as a general rule more economical and satisfactory results can be obtained with temporary binders. Soap solutions or emulsions of asphaltic or semi-asphaltic oils have given good results at small expense in a number of instances where emulsifying plants have been established in or near the park. Other forms of emulsion, as well as salt solutions, have also proved effective, but usually at a somewhat greater cost. When soap solutions of oil are employed it is necessary to give the road more attention than when heavier binding emulsions are used, especially in cases where considerable loose material occurs upon the road. The reason for this has already been considered, and it is only necessary to add that it does not constitute a serious objection when applied to park roads, as facilities are usually such that the work can easily be handled. A choice between permanent and temporary binders for use on park roads may depend upon any one or more of the conditions already mentioned for the various other classes of roads, but in particular where dust from outside sources is likely to be carried upon the road in considerable quantity the temporary binders are to be preferred.

Two bids were received Dec. 22, by the New York State Superintendent of Public Works for Contract No. 20 on the Barge Canal. Sundstrom & Stratton, New York, bid \$1,973,800 and the American Pipe Mfg. Co., Philadelphia, bid \$4,913,168. The engineer's estimate was \$1,173,000. The contract calls for dredging a channel in the Mohawk River from Rexford Flats to Little Falls, N. Y., a distance of 58 miles.

Negotiations for the formation of a railway combine of all the Russian lines operated by private companies are now being considered.

Dust Prevention in the Parks of Boston, Mass.*

BY JOHN A. PETTIGREW,†

We were so favorably impressed last year with our experience in the use of oil for laying dust on our parkways that we continued its use this season. From 12 miles of roadway treated with oil in 1906 we extended the treatment in 1907 over our whole system of roads—about 44 miles. The results are most satisfactory. In point of efficiency there is nothing to be desired, the dust being kept down perfectly by night as well as by day.

The oil treatment is cheaper than watering. Mr. C. E. Putnam, our engineer, a few years ago, after careful observation, computed the cost of watering in Franklin Park at \$189 per mile of 30-ft. roadway, watering being done on 182 days. The cost for the same service on Commonwealth Ave., for 230 days, was \$883 per mile of 30-ft. roadway. Commonwealth Ave. represents the most costly part of the system, and Franklin Park the least costly in point of dust laying. In view of the fact that cost of team hire is greater and hours of labor shorter than when the estimate was made, an average of \$680 per mile per annum might be considered a low estimate of the present cost of dust suppression by the watering method. These estimates may seem a little high for watering; it must, however, be borne in mind that watering is done in the park department whenever the dust flies and the thermometer is not lower than 24 degrees F.

Oiling operations were commenced last year on April 3, since when to Nov. 12, 1907, the total cost of oiling was \$352.67 per mile of road, 30 ft. wide, or at the rate of 2 cts. per sq. yd., the amount of oil used being 1.49 pints per square yard. The dust season was not yet over; the result, however, was not much affected, as we had considerable stock on hand; sufficient to run until Nov. 25.

In addition to the effective laying of the dust we find that the asphaltum in the oil has a binding effect on the surface of the road, and less surface repairs are necessary. We have been able in the middle of August this year to lay up our road rollers for the season, and, excepting for a portion of one of our parkways, which insufficient appropriation has prevented our repairing, the roadways are in good condition. The surface of the roads being better fixed, less washings result from rain, and less gutter scraping is necessary. It is even reported that the catch basins on their fall in cleaning up did not contain half so much material as usual. The softer footing on an oil-treated road is a benefit to horses. The cost of shoeing, too, we find, to be reduced. We apply the oil in the form of an emulsion. The first application of the season contains about 16 per cent of oil,

to form a basis; renewals contain from 8 to 10 per cent of oil. Renewals are made in from 10 to 25 days, according to location and the use to which the road may be subject. As for instance, Commonwealth Ave., between Arlington and Brookline Aves., requires renewals, or rather reinforcements, at intervals of 8 or 10 days, while from Brookline Ave. to the Newton line renewals are required only once in 11 to 16 days; Columbia Road, Arborway and Jamaica Way, with the Fens, 14 to 16 days, while Franklin Park, where automobiles are excluded, requires renewals only at intervals of 20 to 25 days. We prefer to apply the oil in the form of an emulsion, because of the ease with which a treatment can be given and the absence of any annoyance resulting to users of the drives. Carriages may follow immediately after the distributing sprinklers without much danger of being soiled, while all danger is removed after an hour or two. Dust will collect on any road, by accretion, by dust blowing from other sources, or by attrition of the road itself, beyond the power of any dust layer for any great length of time to prevent. The use of a thin oil emulsion frequently serves to saturate this moving dust at slight expense.

In the manufacture of our emulsions we use steam pumps, which do the work of transference of materials and their emulsification by agitation. The formula is 10 lb. to 15 lb. of soap dissolved in 50 gals. of water, to each 100 gals. of petroleum. The soap is placed in barrels of water and dissolved by steam heat, then pumped into the stock reservoirs, which are simply street-sprinkler wagons. To each barrel of soap and water, two barrels of petroleum are added. The pump is then attached to the tank of the sprinkling wagon and the contents agitated until emulsified. This forms the stock, which contains 66 per cent of petroleum. The stock is then run out to the work, and forms the supply for the sprinklers working on the drives, the transfer being made by gravity flow, the stock wagons being set on slight elevations and large transferring hose being used. This method is crude; experiment might devise something better. Possibly compressed air could be used to advantage. Each stock tank will serve to fill four to six street sprinklers, according to the percentage of oil required in the application to the road. This we find to be from 16 per cent on the first application down to 5 to 8 per cent for renewals, as stated before. We find the ordinary street hydrant to be sufficient for the emulsification of the stock with the added water in the sprinkling wagon.

We are still in favor of a thin rolling cushion of coarse sand or fine screenings, saturated with oil. This is, however, hard to maintain on curved roads, the swing of the wheels throwing it to the outer side of the curve. We believe that this loose, rolling cushion helps to release the air suction below the tire, which is so de-

*A report submitted at the First International Road Congress, Paris, France.

†Superintendent of Parks, Boston, Mass.

structive to the road binder. Fine or dead sand of a yellow color makes a very pleasing surface, but must not be too heavily treated with oil, or a hard asphaltum surface will result, which has a tendency to scale.

I have not added the cost of the very slight cushion of sand, which we like to, but do not always, give the surface of the road before oiling, for the reason that it more properly should come under the head of road repairs than that of dust suppression. Under the water treatment we should have made, during the past season, not less than three or four applications of stone screenings, and rolled them into the surface. One application this year under the oil treatment has been sufficient. We find that cottonseed oil soap is the best we have tried for the oil emulsion. The oil we use is Texas oil, for which we pay, net, 6½ cts. per gallon. Small "pot holes," formed by the water settling in small depressions of the roadway, and being forcibly ejected, along with road material, by the tires of the automobiles, are rarely found in our oil-treated roads.

The Oronogo Circle Mining Co., of Oronogo, Mo., is using a small suction dredge for cleaning out its sludge pond, and finds that it is possible to convey, by means of the dredge pump, the sediment from the pond to the settling tanks, whence it eventually is removed to the sludge mill, the lead and zinc ores being finally separated from the valueless gangue and deposited in the ore bins. Relieved of the residue of mineral the gangue is carried away to the waste pile. The dredge pump has a capacity of removing 20 cu. yds. of slime per hour, but this capacity is seldom reached, the average volume of sediment removed being less than 10 cu. yds. The boat which is 10 x 20 ft. in size is operated by a 15 h. p. motor which also runs the dredge pump.

The U. S. Navy Department is calling for bids for constructing a dry dock at the proposed naval station at Pearl Harbor, Hawaii. The dock is to have an overall length of 1,195 ft. and approximately 120,000 cu. yds. of concrete will be used in its construction. An innovation so far as American docks are concerned is that there will be four caisson seats, two as usual at the entrance to the dry dock and two others near the middle of the dock, dividing the main structure into an inner and outer dock. There will be two steel caisson gates and the arrangements will be such that with a ship in the inner dock the outer dock may be filled and emptied independently, thus allowing the ship upon which the most extensive repairs are to be made to remain in the inner dock, while ships with minor repairs are being docked in rapid succession in the outer dock.

About 3,214 miles of railroad was built in the United States in 1908.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods and Costs of Lining Ditches and Canals.

In our issue of Dec. 2, 1908, we gave an account of some experiments made by Mr. B. A. Echeverry of the University of California Agricultural Experiment Station, as to the seepage of water from ditches lined with various materials. From the same pamphlet on this subject by Mr. Echeverry, we reprint the following as to methods and costs of lining irrigation canals and ditches in Southern California, giving the experience of various companies for a period of over 20 years. The costs showing the price of materials and labor are given in most examples.

Canals were first paved to prevent seepage and erosion; and to permit the use of an economical section. This paving was

and squirrels from burrowing through the banks; (3) It should prevent vegetation; (4) It should prevent scouring; (5) It should not be easily damaged by the tramping of cattle and by the action of the weather.

No doubt concrete will answer for all these requirements, but cheaper linings in many cases will be more economical.

A study of the various types of linings used in Southern California shows that they can be classified as follows:

(a) River boulders set in lime mortar and pointed with cement mortar.

(b) River boulders or cobbles placed behind a wooden form and cemented together with cement mortar rammed between the cobbles.

(c) Cement concrete from 3 to 6 ins. thick.

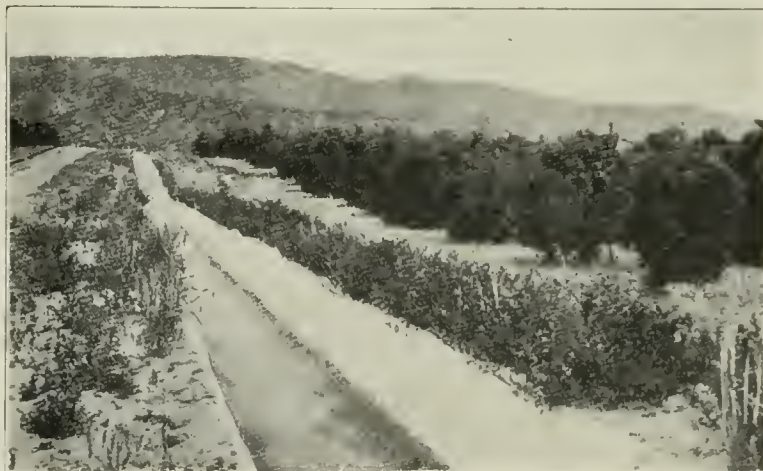


Fig. 1.—Canal Lined with Cobbles Set in Lime Mortar.

then improved upon by paving and cementing. Plastering with cement mortar and the use of concrete for lining came into use soon after.

At about the same time the use of steel or cement pipes was introduced. They have since become much in favor, when the volume of water to distribute is not large, and have to a great extent replaced the smaller open ditch.

While there is no doubt that cement in some form will always be the most generally used material for canal lining, it is expensive and its use is only justifiable where the value of water is very high, or where excessive seepage must be stopped.

Other considerations besides seepage must, however, be studied before one can decide whether it will be beneficial to line the water channels, and other linings should also be investigated.

A good lining should fulfill the following requirements: (1) It should stop seepage; (2) It should prevent gophers

(d) Cement mortar plaster ½ to 1 in. thick.

(e) Heavy road-oil.

(f) Clay puddle.

RIVER BOULDERS SET IN LIME MORTAR AND POINTED WITH CEMENT MORTAR.

This method has been extensively used in the San Bernardino Valley. This type of lining was probably introduced in 1882 to 1883, when the Ontario Colony Enterprise, receiving its water from the San Antonio Canon, paved its canal, 5 ft. wide at the bottom, 6 ft. wide at the top, and 2½ ft. deep, with rocks laid in hydraulic lime mortar and plastered over with cement mortar. This lining was 8 ins. thick and cost about 60 cts. per lin. ft., or about 6 cts. per sq. ft., which is very much cheaper than the average cost per square foot of such work since then. This low cost is probably accounted for by the cheap Chinese labor used at that time, the rate being \$1.25 per day; also the small cost of the lime, \$1 a barrel, and the rock not having

to be handled at great distance.

The cement plaster was mixed in the proportion of 1 part of cement to 3 parts of sand with lime mortar. The bottom was finished with a thin coating of cement and sand in equal quantities. The lime mortar was 1 part of lime to 5 parts of sand.

This type of lining, while largely used since then, is now employed mainly where repairs are necessary. Accurate data as to cost and details of construction are difficult to obtain. A great deal of this work

clean sand and is applied about $\frac{1}{2}$ in. thick, giving a smooth surface.

The size of the ditch thus lined was $2\frac{1}{2}$ to 3 ft. wide at the bottom, about 4 ft. deep, with side slopes of about 1 on 1. (Fig. 1.) The approximate cost was 15 cts. a cubic foot. The price of labor and materials was as follows: Cement, \$3.75 a barrel; lime, \$1.30 a barrel; ordinary labor, \$2 per nine-hour day; masons, \$3.50 to \$4 per eight-hour day.

The method used by the Crafton Water

RIVER BOULDERS OR COBBLES SET IN CEMENT MORTAR.

A good example of this work is a section $3\frac{1}{2}$ miles long on the main canal of the Hemet Land & Water Co. One mile of this canal has a bottom width of 4 ft., a depth of 3 ft., and a top width of 7 ft. (Fig. 2.) The remaining $2\frac{1}{2}$ miles have a bottom width of 3 ft., a top width of 6 ft., and a depth of 3 ft.

The canal was excavated with scoop scrapers and shovels. No form was used in the excavation, the cross-section being finished, ready for the lining, by the shovellers. After the excavation, the banks were well moistened by letting the water into the excavated canal and holding it by earth dams. When the banks were thoroughly wet the water was drained out and the lining put on.

The lining consists of cobbles, most of them not less than 6 ins. in dimension, placed in the cement mortar. The bottom was constructed first, the cobbles being laid in the bed of cement mortar and the space between cobbles well filled in and finished smooth and to grade. This cement mortar for the bottom consisted of 1 part of cement to 4 parts of clean river sand. A little lime was added to this mortar.

Closely following the lining of the bottom came the lining of the sides. (Fig. 3.) For this, mold frames and mold boards were used. The frames were placed 5 ft. apart and so constructed that the mold boards were held in place, against the frames by a $\frac{3}{8}$ -in. iron rod. The mold boards could be put in one at a time, and one section 20 ft. in length was finished at one time.

The mold frames having been put in position and the lowest mold board placed on each side, a layer of cement mortar was spread on the bottom; in this mortar were embedded cobbles, another layer of mortar put on top of these cobbles, then successive layers of cobbles and mortar until the side lining was completed for the section. Mold boards were put on as the lining was built up. The mixture was also tamped during construction to assure the filling of all spaces between cobbles. The ingredients used for the mortar in this lining of the sides were 1 part of cement to 6 parts of river sand. After the forms were removed the sides and bottoms were finished with a very thin wash of neat cement.

The cost of cement was \$3 a barrel, delivered on the grounds. The cobbles were close at hand. The cost of labor was \$1.75 for common labor per nine-hour day and \$3.50 for masons per nine-hour day. The total contract price for excavating and lining the ditch was \$25,000, or an approximate cost of 13 cts. per sq. ft., for the lining.

CEMENT CONCRETE.

The best examples of this kind of construction are seen south of Los Angeles near Orange, Santa Ana, and Anaheim. In this vicinity two irrigation companies, both



Fig. 2—Canal Lined with Cobbles Set in Cement Mortar.

has been replaced with pipes. The ditch known as the Highlands Ditch, and the Old Redlands Ditch, known as the South Fork Ditch, both diverting water from the Santa Ana River, are paved and cemented. While parts of these ditches were first paved with cobbles or rocks without the use of lime or cement mortar, or paved with cobbles or rock faced with cement mortar without the use of lime mortar, the more recent type of construction consists mostly of cobbles laid in lime mortar and pointed or faced with cement mortar. The method of construction used by the Bear Valley Water Co. is as follows:

The ditch is excavated to a definite cross-section, this cross-section being of such size that after receiving a lining of about 1 ft. in thickness it will be the required finished cross-section. After the excavation, mold frames with boards are used to guide the lining work; between the mold boards and the sides is a space of 1 ft., which is the thickness of the lining. Into this space a layer of cobbles about 1 ft. in thickness is built, with the interstices filled with small stones; a grout formed of 1 part of lime to 7 parts of clean, sharp sand is then poured in and tamped in order to fill all voids. The lining of the sides is built up in this manner in consecutive layers 1 ft. at a time. The bottom is usually paved before the sides, the mold frame resting on the bottom. The lining is generally allowed a few days to harden, then the mold boards are removed and the cement plaster put on. This plaster is a mixture of 1 part cement to 3 parts of

Co. was very similar. The ditch was excavated with scrapers and shovels. No form was used for lining; the sides and bottom were put in by line, the cobbles being placed to line and grade in lime mortar, the interstices between cobbles being filled and chinked. The surface was evened off by forcing in cement mortar with a trowel, and a coating of this cement mortar about $\frac{1}{2}$ in. thick covered the sides and bottom. The rock lining was about 1 ft.

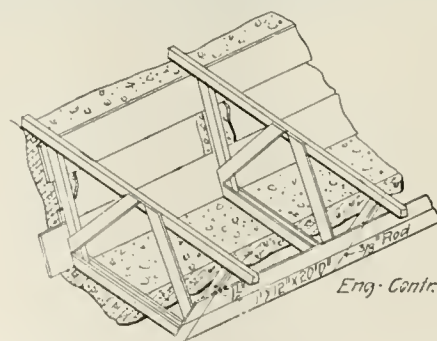


Fig. 3—Method of Lining Hemet Land & Water Co.'s Canal.

in thickness. This work was done in 1893, and was limited to the intake canal (one mile long) of the Crafton Water Co. According to one of the former directors of the company no repairs have been necessary. The work is still in good condition. The average cost of this class of lining would probably be about 13 cts. per square foot. While substantial and satisfactory, a stronger and not much more costly is the next class described.

diverting water from the Santa Ana River, afford good illustrations of this efficient lining. These two companies are the Anaheim Water Co. and the Santa Ana Irrigation Co.

The Anaheim Water Co. has lined its main canal and laterals with a thickness

carefully graded and tamped so as to give a solid, smooth surface. A wooden form is placed on the bottom of the excavated ditch. (Fig. 4.) This wooden form is a trapezoidal trough with no bottom, 16 to 20 ft. long, depending on the size of the ditch; to make it rigid the frames on which the

ing the ditch a slightly curved form at the bottom, the corners being rounded. The form is built with the usual side slopes of $\frac{1}{2}$ on 1; the slope is made flatter for the lower 8 ins., where a slope of 1 on 1 is used. The depth of the form is equal to the depth of the lined section plus the thickness of the concrete. The form for larger canals is similar to the earth form. It is placed on the bottom of the finished earth ditch and properly aligned; the concrete, which is mixed rather wet, is now

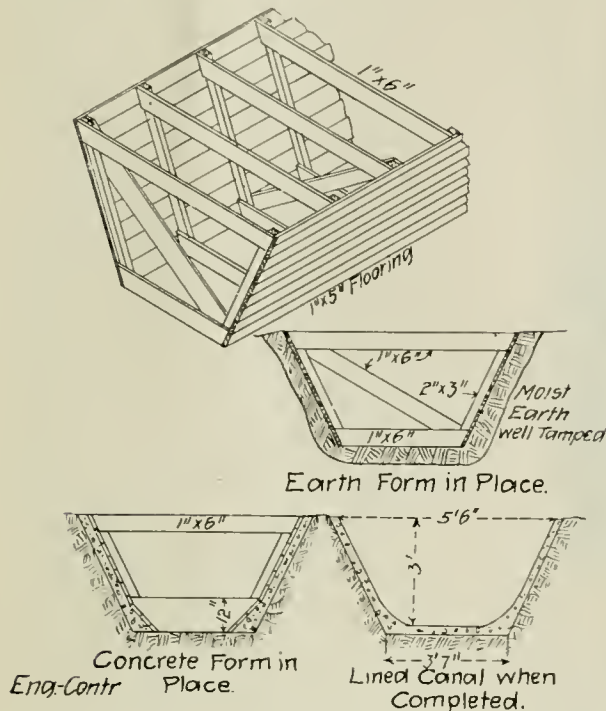


Fig. 4—Method of Lining Anaheim Water Co.'s Canal.

of concrete varying from 4 ins. for the larger canal to 2 ins. for the smaller laterals. The work of lining has been done very thoroughly and with great care. If the canal is an old earth ditch it is prepared for the lining and carefully finished as described below. If the canal is to be constructed and then lined the excavation

side mold boards are nailed are placed every 2 ft. The trough is placed in such position that the axis of the ditch coincides with the axis of the form. Moist earth from the excavation is shoveled behind this form and is well tamped in successive layers; at least 6 ins. of earth on each side is packed solidly in this manner.



Fig. 5—Canal of Santa Anna Valley Co., Lined with Cement Concrete.

is made with shovels, or with teams where more economical, the excavation being generally preceded by a thorough irrigation to settle and soften the ground. The excavated cross-section is made larger than the finished cross-section by the thickness of the lining. The bottom of the ditch is

The earth form is now removed and before the earth has had time to dry the lining is put on. For the lining another form, smaller than the earth form, is used. For some of the laterals this form was given a peculiar shape (Fig. 1), with the idea of strengthening the lining, and giv-

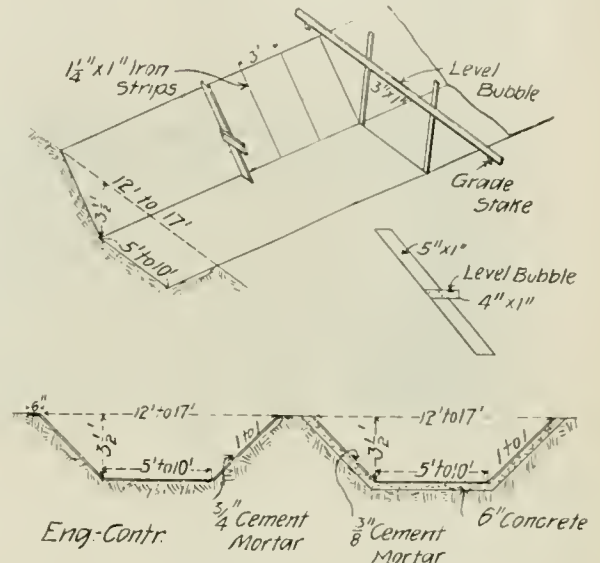


Fig. 6—Method of Lining Gage Canal.

thrown in the space between the form and the earth and well tamped. The side lining having been completed, the form is removed and the bottom lining put on. Wherever possible the concrete is kept wet while setting by allowing water to run in the ditch, and retaining it by earth dams. The concrete is made of 1 part of cement to 7 parts of coarse gravel of varying size.

The main canal which is lined has a bottom width of 5 ft., a depth of $4\frac{1}{2}$ ft., side slopes of $\frac{1}{2}$ on 1, and the thickness of the lining is 4 ins. The cost per square foot was approximately $10\frac{1}{2}$ cts. The cost of cement was \$2.85 per barrel. The cost of gravel was 60 cts. per cu. yd., and the price of labor used in finishing the ditch \$1.75 per day. The price of labor in concreting the ditch was \$2, foreman \$3 per day. For a smaller canal of $1\frac{1}{2}$ ft. width, 3 ft. deep, slopes of $\frac{1}{2}$ on 1, the thickness of the lining was 3 ins. for the sides and 4 ins. for the bottom, with curved or reinforced corners. The cost was 114 cts. per sq. ft., including excavation. The cost of labor and material was higher—cement \$3.30 per barrel, gravel \$1 per square yard, and all labor \$2 per day. The approximate cost for finishing the sides and bottom and for lining (excluding the main excavation) would be 10 cts. per sq. ft. for a 4-in. lining. A corresponding cost for a 3-in. lining (including finishing and lining) would be about 8 cts. per sq. ft.

Some of the smaller laterals are 8 ins. at the bottom and 18 ins. in depth, side slopes $\frac{1}{2}$ on 1. A lining 2 ins. thick costs nearly 6 cts. per square foot.

The Santa Ana Valley Co. has lined a portion of its main canal above the town of Olive, in Orange county (Fig. 5); the lining is a good example of this kind of work. The canal is $10\frac{1}{2}$ ft. wide at the bottom, 12 ft. deep, and 15 ft. wide at the

top. The lining is $2\frac{1}{2}$ to 3 ins. in thickness and was constructed in very much the same manner as the work of the Anaheim Union Water Co. The cost of preparing the sides and bottom for the concrete lining and of lining was 8 cts. per square foot.

1. Serious breaks in the canal, causing large waste of water and inconvenience to irrigators. Large fills were always in danger of breaking, because of settlement of the ground and because of the holes dug in the banks by burrowing animals.

2. Rapid growth of weeds, which decreased the velocity of flow of the water, thus diminishing the carrying capacity.

3. Large losses of water due to seepage.

In 1890 it was decided to remedy these conditions by making an experiment in

stretching at the bottom between the 20 ft. grade stakes, and the bottom was then cut to grade. Strips of iron, 1 in. wide and $\frac{1}{4}$ in. thick, and about equal in length to the length of the sloping sides, were placed on the sides every 3 ft., extending up and down the slopes, the slope given them being the slope of the finished ditch. They were set in position by the use of a specially constructed device as illustrated, which gives the correct slope, the grade line giving the proper position for the lower end of the iron rod.

These iron strips were set every 3 ft. along the slopes. A sharp iron straight edge, a little over 3 ft. in length, was used to shave off the irregularities between them; or if below the alignment, the depression was filled in and well tamped. Usually there were two gangs of men; the rough finishers came first and removed the larger irregularities, tamping the sides and bottom; then the smooth finishers brought the surface exactly true.

Method of Lining.—The cement men usually followed the finishers, about a half day later. If the earth had dried, it was usually well sprinkled. Wooden strips $1\frac{1}{2}$ ins. in width, $\frac{3}{4}$ in. thick, and equal in length to the width of the sloping sides, were placed flatwise on the slopes. They were placed 3 ft. apart, and served as guides to a straight edge which assured a uniform thickness of $\frac{3}{4}$ in. mortar.

The mortar was mixed on top of the bank in galvanized iron portable mixing boxes, and spread uniformly between the wooden strips on the slopes. With the straight edge as a guide, all irregularities were removed, and the mortar was finally compacted with the trowel. After the



Fig. 7—Gage Canal, Lined with Cement Mortar.

canal lining by applying a cement mortar plaster on the sides and bottom of the canals. The method used as described by Mr. Irving and supplemented by information given by Mr. Mylne, the present engineer of the company, is as follows:

CEMENT MORTAR.

This method is probably used more extensively in southern California than all the other methods combined. It has proven efficient and its cost is small. Examples of this class of lining are numerous all through the irrigated districts of southern California. Some of the best types are in the vicinity of Riverside, where the three irrigation companies—the Gage Canal Co., the Riverside Water Co., and the Jurupa Co.—have used it extensively. The lining usually consists of a cement mortar plaster, varying from $\frac{1}{2}$ to 1 in. in thickness. Various methods are used in preparing the canal for the lining and in applying the lining.

The Gage Canal Co. began making improvements on its main canal in 1886; from 1886 to 1890 this was reconstructed, the total length being 20 miles. In 1890 the control of the Gage Canal Co. passed to the Riverside Trust Co. The conditions prevailing at that time are fully discussed by Mr. Irving, the engineer of the company, in the report of Irrigation Investigations for 1901 (part 2), prepared by the Office of Experiment Stations. The conditions were those usually encountered by other systems where the canals are not lined, viz:

1. Serious breaks in the canal, causing large waste of water and inconvenience to irrigators. Large fills were always in dan-

ger of breaking, because of settlement of the ground and because of the holes dug in the banks by burrowing animals.

2. Rapid growth of weeds, which decreased the velocity of flow of the water, thus diminishing the carrying capacity.

3. Large losses of water due to seepage.

In 1890 it was decided to remedy these conditions by making an experiment in

stretching at the bottom between the 20 ft. grade stakes, and the bottom was then cut to grade. Strips of iron, 1 in. wide and $\frac{1}{4}$ in. thick, and about equal in length to the length of the sloping sides, were placed on the sides every 3 ft., extending up and down the slopes, the slope given them being the slope of the finished ditch. They were set in position by the use of a specially constructed device as illustrated, which gives the correct slope, the grade line giving the proper position for the lower end of the iron rod.

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Fig. 8—Unlined Canal Near Lemoore, Showing Vegetation.

grade stakes were spaced at intervals of 20 ft. A level rod or cross-section rod of sufficient length to reach from one bank to the other was held at right angles to the ditch, with one end on the grade stake and the corresponding stake set on the other bank. The location of the bottom stakes was obtained by measuring from this rod, by which means they were placed in alignment and to grade every 20 ft. A line was

stretched at the bottom between the 20 ft. grade stakes, and the bottom was then cut to grade. Strips of iron, 1 in. wide and $\frac{1}{4}$ in. thick, and about equal in length to the length of the sloping sides, were placed on the sides every 3 ft., extending up and down the slopes, the slope given them being the slope of the finished ditch. They were set in position by the use of a specially constructed device as illustrated, which gives the correct slope, the grade line giving the proper position for the lower end of the iron rod.

The cost of this class of work, including preparation of the slopes and bottom, and their lining, varies from $3\frac{3}{4}$ to 4 cts. per square foot.

The Riverside Water Co. has plastered a large portion of its water channels in a very similar manner, the cost being nearly the same.

The Jurupa Canal is lined with cement plaster; the thickness of the lining, however, is only $\frac{1}{4}$ to $\frac{1}{2}$ in. The earth ditch was not brought to grade as accurately, nor the sides finished as smoothly, as for the Gage Canal Co. The water channel was trimmed approximately with shovels; the sides and bottom were then sprinkled and the mortar spread with trowels to a uniform thickness as nearly as possible. The cost of this lining was not obtainable but very similar work used by the Escondido Irrigation District for some of its channels cost from 15 to 20 cts. per sq. yd., or from 1.66 to 2.22 cts. per sq. ft.

A smaller ditch near Hemet, the Little Valley Ditch, 2 ft. wide at the bottom, $1\frac{1}{2}$ ft. deep, with side slopes of 1 on 1, was lined with cement mortar plaster 1 in. thick at the bottom, and $\frac{1}{2}$ in. thick at the sides. The composition of the mortar for the bottom was 1 part of California cement to 4 parts of sand; for the sides it was 1 part of cement to 6 parts of sand. The cost of preparing the channel and lining was 18 cts. per lin. ft., or 2.88 cts. per sq. ft.

The San Jacinto Water Co., also in Riverside county, has its main canal lined in the same manner as the Gage Canal; the length of the canal is 11 miles, the bottom width is 3 ft., the depth $2\frac{1}{2}$ ft., and the side slopes 1 on 1.

That this type of lining has been successful there is no doubt. Mr. Irving, former engineer for the Gage Canal Co., states in his report that after a test of ten years the lining more than justified their expectations. The cost of repairs after four years' use was very small, less than $\frac{1}{2}$ of 1 per cent of the capital cost in four years.

That there are conditions under which this lining will not be entirely satisfactory has also been demonstrated as follows:

1. For water channels constructed in heavy adobe soil, subject to heaving, it has cracked badly. This is noticeable in parts of the canal of the San Jacinto Water Co.

2. For water channels built in fills, where the ground is subject to settlement.

A better construction in this case is to line the canal with masonry of the type "a" or "b", previously described. The Gage Canal has used masonry very similar to class "a" for the lining of canals when in fill or made ground. This masonry is about 6 ins. in thickness and is composed of building stone laid in mortar whose ingredients are 1 part of Portland cement, 3 parts of fat lime, and 20 parts of sharp sand. All external surfaces exposed to the action of the water are coated with $\frac{3}{8}$ in. of cement mortar, composed of 1 part of cement to 3 parts of sand. The cost of

this class of work, which is very similar to class "a", but not so thick, is about $11\frac{1}{2}$ cts. per sq. ft.

The thin plaster lining is subject to rupture where gophers or squirrels burrow behind it, or under it, as the lining has not sufficient strength; also if storm water washes out some of the back filling.

It is probable that this kind of lining would not resist the climate of a country subject to very cold weather, in which case the stronger lining with proper drainage to prevent the accumulation of water behind the lining would be needed.

The instances where road oil has been used for canal or reservoir lining are few. The only example of its use for canal lining in California known by the writer, is at Lemoore, in Kings county, on the Madison branch of the Lemoore Canal & Irrigation Co.

In this locality the canals are shallow, the velocity of the water is small, and the growth of weeds and aquatic plants in the canals is abundant. (Fig. 8.) A large resistance is offered to the flow of water, which means a small carrying capacity, and a large loss due to seepage and evaporation. It is necessary for the irrigator to clean these frequently, sometimes as often as once every two weeks. The labor and cost are considerable.

Mr. McLaughlin, secretary of the Lemoore Irrigation Co., tried as an experiment the use of heavy road oil to prevent the growth of vegetation. The oil was applied in November, 1905, on a length of $1\frac{1}{2}$ miles of the main canal. The canal is about 20 ft. wide and about 1 ft. in depth.

The oil used was crude petroleum from the Sunset District southwest of Bakersfield and contains a large percentage of asphaltum. Its specific gravity is $11\frac{1}{2}$ on the Beaume scale. This oil when cold will not run freely. It was used hot and sprinkled with an ordinary road sprinkler. The ditch had been previously cleaned of all vegetation and allowed to dry. The road sprinkler was driven first on the bottom of the ditch and then on the banks. The oil was applied at the rate of $1\frac{1}{2}$ gals. per sq. yd. The oil was then thoroughly harrowed in until it was well mixed with the soil, which was very sandy.

When examined in May, 1906, about seven months after the application of the oil, there was no vegetation in this part of the canal, while other parts of this same canal which had received no oil and had been cleaned two weeks previously showed a vigorous growth of vegetation. The contrast is very striking and clearly shows the value of oil in preventing the growth of aquatic plants. Not only was this part of the canal free from vegetation, but it was only about one-third full, while the canal full of weeds had to be full to carry the same amount of water.

An objection might be made to the use of oil for canal lining because of the fear that the oil might be carried to the fields in sufficient quantity to injure the crops.

Mr. Laughlin states that in this case they had no trouble from this source.

An example of the use of oil for lining reservoirs is found near Bakersfield, where a small reservoir 275 ft. long and 75 ft. wide is built in almost pure, coarse sand. A centrifugal pump delivered to the reservoir 2,250 gallons of water per minute for 12 hours, and it would leak out as fast as poured in. It was then decided to use road oil to prevent this excessively large seepage. One hundred and eighty-five barrels of heavy oil (11 specific gravity Beaume scale) were poured while hot on the bottom of the reservoir. Since one barrel of oil contains 42 gals., the rate at which the oil was applied was 3.31 gals. per sq. yd.

While for the Lemoore Ditch the oil was harrowed into the soil, in this case the oil was poured on the surface and allowed to soak in. This formed a tough asphaltum crust of about 3 or 4 ins. in thickness. The seepage was greatly reduced and now the reservoir can be rapidly filled with the same pump.

Another example of the use of oil for lining a reservoir is near Los Angeles—the Ivanhoe Reservoir. Here it was found necessary to protect the sloping banks from the erosive action of the waves. On the slopes were spread 3 ins. of river sand, fairly clean, and thin oil (16° to 18° Beaume scale) was sprinkled on the sand and raked in. The amount of oil used was 2.3 gals. per sq. yd., or 13.35 per cent of the volume of the sand. The slopes of the reservoir were 4 on 1 and $2\frac{1}{2}$ on 1. This lining was being completed when the writer examined it. It has so far answered in a satisfactory manner the purpose for which it was intended. A letter was addressed to Mr. Wm. Mulholland, superintendent of the water department of the city of Los Angeles, inquiring as to its behavior, and his reply, under date of December 20, 1906, is as follows:

"The oil lining of the Ivanhoe reservoir has proven a success with the exception of the southern embankment, on which the work was poorly and hastily done. We had a very severe northern gale about a month ago that raised waves at sufficient height to spray clear over the bank, although at that time there was fully 4 ft. of clearance. The continued action of this storm for 24 hours or more cut many holes in the slope, but an examination of the broken places showed that the oil had penetrated but an inch or two and was hence insufficient to withstand such violence." Mr. Mulholland further states that with properly executed work the method would prove a complete success.

It will be noted that in this case comparatively light oil was used. It is the writer's belief that heavy road oil would be more efficient in resisting wave action, erosion, or scouring due to water.

From observations of the behavior of oil on roads or streets in resisting the erosive force of running water during heavy rain-

It would seem that an oil lining for canals would allow a very high velocity. Many oiled streets having a steep grade have been constructed with the gutters built of exactly the same materials as the street. These gutters during heavy rain storms have had to carry a large volume of water and the velocity was high, still the gutters were not in the least cut up.

A statement from Mr. Theo. White, of Los Angeles, who has made a special study of oiled roads, gives us an idea of what might be expected of oil lining for ditches. "The whole country was flooded and it gave us a good test of our oiled roads. There is a road running into San Bernardino on a grade of about 6 per cent, about 300 or 400 ft. from a bench down into a creek bottom. The road had been oiled a second season and there was a good oiled surface. The water rushed down the middle of that road, because the ditches could not carry such a great volume of it, and it did not make a scratch on the road, but a half mile south there was a road of about the same grade which was so badly washed that it could not be used until it was repaired—a road that was not oiled. Between Pomona and Freeman there was a great quantity of water came from a canon and struck the oiled road at right angles at one point. It came from the west, and on the east side of that road there was a margin of 6 or 8 ins. of the surfacing material that the oil had not touched. The rain passed over the oiled surface, and when it came to that which was not oiled it cut it right out. Upon the same road within the city limits of Pomona the road was surfaced with decomposed granite, packed down hard, and a very nice road during the summer, but it had not been oiled. The same storm cut it all to pieces. On one stretch of a quarter of a mile the road material was fairly washed out into the fields alongside the road."

These examples and observations on the use of oil teach us that it can be used to prevent vegetation in the ditches, to greatly decrease seepage in the sandy soil, and to probably resist erosion due to wave action, or running water.

PUDDLED CLAY LINING.

This method of lining had not been used to any extent in the irrigated districts investigated, and the writer could not learn of any systematic work of the kind.

The cost of this lining would depend on the distance the clay would have to be hauled and the ease with which it can be loaded, and on the way the clay is applied.

The cost of such a lining would be mainly the cost of the clay; for a lining 4 to 6 ins. thick this cost would probably not exceed 1 to 1½ cts. per sq. ft.

The large covered reservoir being constructed at Honor Oak by the Metropolitan Water Board of London, England, is nearing completion. The work has been under way for three years.

Building and Maintaining Railroad Crossings.*

BY W. C. SPARKS,†

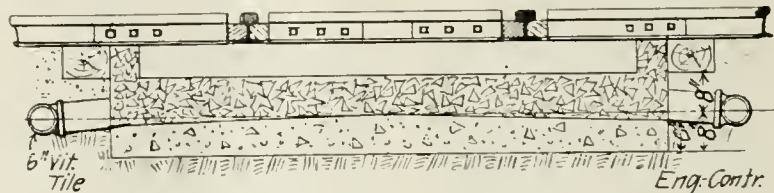
The maintenance of railroad crossings is a subject in which general managers and engineers of interurban lines are very much interested. Owing to the recent building of interurban lines it has generally fallen by contract to the various traction companies to construct, install and maintain their crossings with the steam lines. With some of the larger interurban properties which also operate city systems the question of maintenance of railroad crossings has become an important item and is an expense which must be considered by the management. On some of the larger systems it is almost equally as important as the question of tie renewals.

The growth of interurban lines has been rapid, and there are now being operated 50-ton electric cars instead of 12-ton cars, at speeds increased almost in proportion. This increased weight of interurban cars, together with the greatly increased tonnage of locomotives, increased weight and carrying capacities of steam cars, increased length of trains in proportion to the increase of tonnage of locomotives, have caused much trouble in maintaining track

steam rails the easier rails should extend at least 15 ins. beyond the first joint, and such joints should be supplied with rolled steel fillers.

Fifth. Rolled steel fillers should be used at intersections and at points where easier rails extend beyond joints.

This type of crossing was designed to prevent the hammering and battering down of the crossing at flange-way intersections. It generally consists of rectangular manganese plates at the intersections of flange-ways. Some manufacturers, however, have made designs which carry the manganese plate on the steam rails from intersection to intersection. The excessive cost of this type of crossing has prevented many interurban roads from using it. The cost of the hard-center type, as a rule, is about two to three times the cost of the standard built-up crossing, the cost depending upon the angle of the crossing. The first cost of the manganese type seems so great that, as a rule, most companies decide to purchase the standard built-up type. For experimental purposes, in May, 1907, the Indiana Union Traction Co. installed two crossings of this type at a location which was in almost constant use by the steam road at a cost about double that of built-



Railway Crossing with Concrete Foundation.

crossings under the constant hammering of such service.

Generally speaking, there have been developed and are now in use, two types of railroad crossings, namely, the built-up crossings and the manganese steel or hard center crossing. The built-up type of crossing is in general use by interurban lines at crossings with steam roads. A few points which should be considered in building a crossing of this type are:

First. Great care should be exercised in the measurement of the crossing, special attention being given to the reading of the angle, gauge and compromise joints and their drilling.

Second. Easer and guard rails should be of the same section as the running rails, and should be full section of rail.

Third. Where the rail section permits, bolts should not be less than 1 in. in diameter, and preferably 1½ ins., applied with proper lock nuts.

Fourth. If the crossing is to be run over at high speed both by steam and interurban cars, easier rails should be installed in both tracks. Short easers on the interurban rail will suffice, but on the

up crossings. They have now been installed nearly two years, and there is no perceptible wear at the flange-ways. At the present time they look to be good for at least ten years longer, or about four or five times the life of the standard crossing.

Nothing affects the life of a crossing of any type more than the method of installation.

There are different opinions as to the kind of ballast which should be used as a foundation for crossings. Some companies use gravel; others use crushed stone; while others are in favor of concrete. On the lines of the Indiana Union Traction Co. crushed stone is used almost entirely for crossing foundations. The stone beneath the ties should be at least 18 ins. in depth and thoroughly bar tamped. About two years ago, for experimental purposes, the writer put in foundations for two crossings of concrete made of gravel, the mixture being one part cement to five of gravel. The concrete foundation extended 12 in. below the bottom of the crossing timbers and was carried up to the top of the ties. Within one year after the placing of the new crossing on a foundation of this character it was necessary to install new easier and running rails on the steam track. The concrete foundation had proved

*Paper read at the Central Electric Railway Association, Lima, Ohio.

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to be too rigid, and the constant hammering of the steam cars soon battered the running and easer rails on the steam track to pieces, thus proving that in all railroad crossings there should be a certain amount of elasticity. Many steam roads also object to concrete because of the damage to their rolling stock.

The plan which the writer would suggest at this time for consideration and discussion consists of both concrete and crushed stone, and is as follows:

The excavations for the foundation material should be 24 ins. deep. At the bottom of this excavation there should be installed 8 ins. of concrete so shaped that proper drainage can be procured. Upon this concrete base place 8 or 9 ins. of crushed stone to receive the crossing timbers. The stone should not be less than 3-4 ins. nor more than 2 ins. in diameter, and thoroughly tamped when the crossing is brought to proper surface. Fine stone should not be used, as it cements together and prevents proper drainage. By this method the concrete not only serves as the foundation, but acts as a partition, so to speak, between the earth and stone, and thus prevents the mixing of the earth and stone. The crushed stone acts as a cushion for the crossing, and gives the elasticity desired. The writer has never used the above method for installing crossings, but expects to experiment along this line during the coming year.

Another important feature to be considered in the installation of a crossing is the question of drainage. All crossings should be drained with at least a 6-in. pipe, with sufficient fall to keep it clean at all times. Large pieces of crushed stone should be placed over the end of the drain, so that it will not become clogged. A well-drained and a dry foundation is necessary for the successful and satisfactory maintenance of any crossing.

Crossing timbers should be of white or hurr oak, and should be 7 ins. thick, 9 ins. wide, and of the length required. In case of right-angle crossings 10x12-in. timbers should be placed beneath the running rails of the traction company's track. This allows the steam track to be laid on the cress ties, and also affords a means for spiking the running rails of traction line. A tie plan should be furnished to the foreman in charge of the installation of the crossing. Wherever possible the use of crossing plank should be discontinued and crushed stone should be used. This affords an opportunity not only to keep the crossing tightened at all times, but prevents vehicles from using the tracks as a driveway. This refers to crossings on streets and highways. In many instances it has been possible to get the municipal authorities to agree to the use of crushed stone instead of planking, and in almost every instance they are pleased. An effort along this line is time well spent.

All railroad crossings should be exam-

ined by the section foreman whenever he passes over them, and once a week a thorough examination should be made. Special instructions should be given track men to see that the bolts in the crossings are kept tight at all times, as the life of a crossing is materially lengthened by keeping it tight.

At points where crossings are protected by interlockers the tower man should be supplied with a stock of bolts for the crossings, and should see that bolts are tightened daily.

Drains should be inspected and kept open. Crossings should be kept in good line and surface at all times, as the damage done to a low crossing is much greater than if it were in good line and surface.

Maintenance cost of crossings can be materially reduced and the life of the crossing lengthened by the installation of new running and easer rails in the steam tracks before the crossing gets into too bad condition. By careful and accurate measurement of the rails of the old crossing and plans made of the work in detail any machine shop which has a planer can make the running and easer rails at a cost of \$40 to \$50 per set. This price can be materially reduced if the work can be done in the company's shops.

On the Indiana Union Traction Co.'s lines at many locations where the crossing is run over at high speed for both lines duplicate crossings have been supplied. While one is in service the other is taken to the shops and overhauled and repaired. It is then taken to the crossing location and stored for emergency use. The crossings are not allowed to become too badly worn before they are exchanged. This permits having the crossing in the shop at the time new easers and runners are made, which is quite an advantage, as it allows all new parts to be machined and fitted together before taking the whole crossing to its location. This has proved an economical method of maintaining standard built-up crossings, but the writer does not believe it to be as economical as hard-center crossings.

In conclusion, the following points should be emphasized for the economical maintenance of railroad crossings:

First. For interurban crossings with steam lines hard-center crossings should be used, especially at high-speed points.

Second. Keep the foundation dry.

Third. Keep the bolts tight.

Fourth. Frequent inspection by road-masters.

During November the dredging fleets of the Atlantic and Pacific Divisions of the Isthmian Canal, excavated 1,334,577 cu. yds., of which amount 1,179,921 cu. yds. were taken from the Canal prism. Three 20 in. pipe line suction dredges, two sea-going suction dredges, three dipper dredges, and five ladder dredges were at work during the month.

A Plea for the Business Training of the Engineer.*

BY R. A. ROSS.†

The only justification in the eyes of the community for the existence of the engineer are the results which he obtains. His business is a purely utilitarian one, the object being the production of value. Value is not measured by the cost of an engineering construction, but by the results obtained therefrom when used as a tool for the extraction of dividends. The value of the engineer to the community being determined by the results obtained from his engineering, it becomes pertinent to inquire when such results are shown. These become apparent only when the work for which he was responsible has been in operation for a time and operating profits or losses can be determined.

Without drawing the lines too closely there may be conceived to be three stages in the life of an enterprise:

1. The scientific—when the tool is forged by the engineer.

2. The business—when methods of using the tool are evolved and used.

3. The economic—when the results of the tool and its handling become apparent.

The engineer as a purely technical man will consider his work done at the end of the first stage, leaving to other hands the completion of the task and the obtaining of results therefrom. This tendency is fathered by the purely technical nature of the training which he has received, fostered by a lack of business knowledge in which he finds himself deficient and ingrained in his system by the attitude of the business world towards him, which believes the engineer to be lacking in business ability whereas it is only lack of training and confidence.

The general result so far as the engineer is concerned is that by keeping his nose so closely to the technical grindstone he has little opportunity, or even desire, to look up and see what the larger business world is doing with his product; he therefore does not take his real position in the scheme of things and attract that attention to himself and his profession which he should, nor does he do that full justice to the community which has educated him, and which has a right to demand the highest dividend possible on capital invested in his training.

No remark is more frequently heard, especially among financial and business men, than that the engineer does not understand business. And this is in general true. He is therefore hired by a company, and regarded by it merely as a species of glorified plumber. He constructs the tool with which the financial man works and without which he could have no standing in the community, and being given this tool he is able to bring busi-

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†Reprinted from "Applied Science," University of Toronto, Toronto, Ont.

not trained to hear and produce results, for which he and not the engineer is given credit and reward.

The engineer is a man with a trained mind, trained to logical reasoning and deduction, brought up on good, old Euclid, thoroughly grounded in rigid scientific principles and taught to think straight. If, therefore, he applies his logically trained mind to business and economic matters with one-half the diligence which he exercises in his purely engineering functions, it is difficult to see why he should not obtain better results than the business man who generally has had no real training in business, but has absorbed such knowledge as he possesses from the business atmosphere surrounding him—does not read, study, or examine into the real reasons of things, and knows only business usage and custom. If this be doubted, inquire from business friends as to the amount of reading and real study they have given to business matters, it will be found to be inconsiderable. As a matter of fact, the engineer side-steps a business proposition whenever he can, stating in effect, if not in words, that his business is engineering and leaves the business of what should be his work to others, when given a certain amount of study and courage he could settle these questions satisfactory for himself and to the benefit of the public. The reason for this attitude on his part toward the field which promises him an improved status as a citizen, a broader knowledge of the world at large, and increased dividends, is to be found in the fact that the business part of his training is not taken up or even hinted at during his college course.

It is, of course, impossible that an art such as business is can be taught in a college devoted to science, but neither can the art of engineering be taught there. Whether there is a science of business is very questionable. There is certainly nothing in the nature of an exact science, nor even of an approximate science, but there are certain laws and general principles which if absorbed by the student during his college course would give him a different outlook and broaden his horizon. He would at least learn that there is nothing weird and incomprehensible in ordinary business terms or business methods and therefore be encouraged to extend his field of operation beyond the technical so as to embrace the business and economic end of the subject.

If, however, through lack of ability or aptitude in business matters, or through the bent of his mind being purely scientific, he does not find an opportunity to expand in the direction indicated, yet he will at least be able to understand the terms used, and to talk intelligently to men in the business world.

This expansion of the engineer's sphere of usefulness is evidenced in the career of certain engineers in other countries who,

beginning as purely technical men, have since launched out into contracting, and finally added financing and operating, so that they in their business have forged the tools, have used them and have obtained results, and the credit and returns are all theirs.

The rapid expansion of industrialism is making its demands for trained men felt more and more, and engineers are being chosen for administrative offices in large corporations and as the directing forces in large enterprises, and this tendency must of necessity increase, and who are better fitted to operate under directions of the laws of men and with a knowledge thereof than those who have built well under the much more rigid and exacting laws of nature.

In any system of engineering training, science must of necessity be the foundation, but upon this foundation the engineer may erect a superstructure which will be visible to the public, and attract attention to the fact that he is a power in the community. This superstructure, which may readily be a part of engineering, is dedicated to the business and financial departments of his business; without the foundation the structure is useless, but the foundation itself not being visible receives precious little attention from the community when the building is complete. The basement rentals are also low.

The institutions wherein engineers are taught must in justice to the profession keep pace with this tendency, and that they are beginning to do so is evidenced by the fact that a number of colleges in other countries have added to their purely technical studies a course on the business and economic aspects of engineering. In this country, McGill is about to set the example, and it would appear that the other technical schools will have to follow suit or their graduates will be distanced in the race for preferment.

There are two arguments against adding a course of this kind to the curriculum of a science school—

1. That the students are already overburdened with work.
2. The reluctance of the authorities to teach anything but science.

As regards the first, it seems to be a question as to whether certain of the more purely scientific studies could not if necessary be dropped in favor of the more practical course here advocated, but it is thought that this may not be necessary as a fairly extensive course can be given, covering only the principles of business, without overburdening the student, for the reason that his training having been along rather strenuous lines, demanding a high degree of concentration, the study of the mechanism of business will be found to be child's play by comparison.

The second objection can be met by asking whether the college is not for the inculcation of principles. If this is true as

regards science, why not as regards the business of engineering.

The engineer as he develops and gets away from purely technical routine work is supposed to be able to draw up specifications, make contracts, hire and direct labor, and report on properties. These are within his legitimate field as at present understood, and yet all of these demand that he should have in reason a knowledge of money and values, of business methods and some knowledge of law, and that he should be able to present his reports in such a way as to be readily understood by business interests.

The mere expansion of these functions with the same knowledge of principles brings him to a point where he should be able to present a financial scheme for the consideration of financial people, and practically to act as their engineer, promoter and director of the scheme at its inception and thereafter. He should be able to operate it to a successful issue, to obtain commercial results and dividends. To this end, in addition to the knowledge of business which the engineer should have to enable him to draw up specifications, contracts, etc., he should have a knowledge of the general business methods of the community in which he lives. He should understand something of stocks, bonds, bills of exchange, notes, the formation of companies, of partnerships, the general laws relating thereto, the functions and powers of different corporation officials, and the method of incorporating companies. These are matters, the principles of which an engineer trained to study can acquire. To practice is of course a different matter, and results will depend upon his ability in dealing with the world as a business proposition.

His scientific training has taught him to deal with the laws of nature. His business training should teach him how to deal with men and money and the laws relating thereto. Business has not been taught or developed as a science, and it is therefore considered an art, and ability therein can only be developed by practice. But this is so even in engineering, the science of which is taught in the college and the art developed later in the larger world of practice.

It is not expected, nor is it desirable that the engineer should by thus expanding his functions, eliminate the lawyer or financier. But his knowledge of business should on the other hand indicate the necessity for these gentlemen's services, and above all show just when and where their services are needed and enable him to appreciate them at their proper value when given.

In short a business training should develop a new view of his relations to other professional men and place him in the position of engaging their services rather than acting as their servant.

The engineer is a utilitarian to a com-

manding degree and much more so than the other professional men, such as the doctor, lawyer and clergyman. The lawyer is a special pleader and does the best he can with the case given him. The doctor buries his mistakes. The clergyman deals in the future, but the engineer has to deliver the goods and the goods have to be commercial, therefore why restrict an engineer's education to purely scientific subjects, and why not expand his horizon to enable him to take the position in the community which he deserves and can command, and enable him to reap the rewards both in credit and dividends for which such training fits him.

LETTERS TO THE EDITORS.

The Panama Canal Work.

Sirs: I have read with interest your editorial on the Panama Canal in your issue of Dec. 2. The indictment you bring against the Commission covers:

1st: Extravagance.

2nd: Failure to keep cost data.

3rd: Not doing the work by contract.

While the engineering profession, or perhaps more correctly their clients, owe you a vote of thanks for waking up the profession in the matter of cost data, and while it is proper that there should be a journal devoted to the interests of contractors and urging that public work should be done by contract, there are times when cost data is not the most important element in a work, and there are times when public works should not be let by contract, of which I think the Panama Canal is an undoubted example.

In your speculations as to extravagance, you speak of "gross waste of public funds" and of "leaning to the side of charity" for the Canal administration, and yet the only evidence of what the cost should be are some estimates made primarily for the purpose of comparison between different types of canal by the earlier commissions. There is not one single individual now in charge of the Canal work who had anything whatever to do with the estimates or who has the slightest interest in protecting those estimates from any comparisons that the actual cost of the work may disclose.

It was totally impossible for the earlier commissions to make reliable estimates. The operations of the French had been conducted with such extravagance and with methods of work wholly inapplicable so that their experience is no guide. The purchasing agents of the company seemed to want to buy everything that the markets of Europe afforded. A carload of carpet tacks without a carpet on the Isthmus; thirty-six cubic feet of steel pen points in one purchase, were examples in a small way. In a larger way, the machinery and metallic materials on the Isthmus if piled in a heap would have rivaled the great pyramid in size, and it would have taken

a corps of experts many months to tell what part of it was junk and what part of it was machinery that could be used economically. I will refer to this point again.

In the work of excavating the cut, the French used three schemes of operation which would throw little light upon the proper cost of the work. In excavating, they used a kind of chain of buckets which scraped the material up a forty-five degree slope. In another case, they ran a tunnel below the cut, opening up several holes in the roof, through which they proposed to fill trains of cars running in the tunnel. In a third case, they dug a pit in the cut, pumped it full of water and then put floating dredges to work to make the cut by that method. This remarkable scheme was lately seriously proposed by Mr. Bunau-Varilla as a proper plan to build the canal, namely, by first making a lock canal with a summit level 130 ft. high and then putting on dredges to dig out the rock sub-aqueously and gradually convert it into a sea level canal. It is needless to say that these fantastic methods threw little light to guide the footsteps of our earlier estimators of canal costs.

Outside of that, the problem was new. The material of the Culebra cut was a jumble of material. Sometimes the soft stuff was on top and sometimes the rock was on top. Some of it was rock today and slippery mud tomorrow. Whether the sides of the cut would hold up or slip was not known. How much of the sides of the cut would be turned into mud by the water in the canal was unknown. Whether under proper sanitation, labor would be quite effective or very ineffective, were unknown. In short, nothing less than omniscience could have told whether a dollar would buy twenty cents worth of real labor or five times that amount. The earlier Commissions were entirely excusable for erroneous estimates, and you must bring something better than those estimates to compare with the actual cost before you can justly accuse the present administration of extravagance.

As to not keeping cost data, your complaint is limited to the report. I hold no brief from the Commission, and I know no more than you as to their methods, but it is quite possible that they have covered that ground thoroughly, even though it is not included in the report. The Government report on a great work like this is intended for Congress, and an elaborate analysis of cost data might not be as interesting to a Congressional committee as it would be to a meeting of engineers. I think the Commission were entitled to an inquiry on the subject of their cost analysis before you condemn them for not publishing such matters in their annual report. Anyhow, cost data on this work would have comparatively little value, as we are probably not going to build many more Panama Canals, and as a lamp to guide

our footsteps in work outside the tropics, while it would, of course, be interesting and useful, it is certainly not the all important matter in building the Panama Canal.

As to doing the work by contract or otherwise, I have given a great deal of thought to this subject, from the time the Government bought the property, and I take issue with you completely. The object of letting work by contract or of doing it by hired labor, is to do it correctly and economically. Assuming that under competent supervision, the work would be done correctly in either case, we can limit our discussion to the question of economy. While it is true that in small works, where the personality and self-interest of the contractor permeate the entire job, public work can undoubtedly, under ordinary conditions, be done most economically by contract, but when the work becomes of the magnitude of the Panama Canal, the influences that affect the day laborer, which cover the great cost of the work, do not come from much higher up than the immediate foreman. The laborer, or even the foreman himself, will seldom realize whether the chain of responsibility leads finally up to a contractor or a Government officer, and while in theory men will work a little better for a contractor than they will for a Government, the reason for it is that the contractor makes them do it. In this case, the result has to be produced through a foreman, who is a good way from the throne, and the idea becomes of very little moment. On the other hand, to have put this great work in the hands of contractors would have produced many other difficulties.

The great obstacle to overcome in the work, the great menace that threatened its absolute prevention, outside the Pacific Railroads, was the question of preserving the lives of the workers. If contractors took the job and tried to make all the money out of it that they could, as they naturally would do, sanitation would be a secondary consideration, and it was quite probable that a terrific epidemic might halt the work by frightening the Governments that controlled the tropical labor of the world. It was absolutely necessary that the Government should control the sanitation, either by taking charge of it and doing the work or by requiring the contractor to do certain things. I visited the Isthmus with Col. Gorgas on his first trip, to look over the sanitary engineering part of the subject, and I know what a magnificent success he has made of it, and I also know how utterly impossible it would have been for Col. Gorgas or anyone else to have specified in advance in a contract just what the contractor must do in the matter of sanitation. If the Government took charge of the work, it would have to guarantee the contractor certain results, which guarantee was out of the question, or it would have been an endless source of

dispute as to the responsibility for any great amount of sickness that might have occurred on the work.

The only way to have let a contract under such circumstances would have been to put upon the contractor or contractors some tremendous responsibility for the solution of problems that could not then have been foreseen. Now the object of letting work by contract, economically, is absolutely defeated by putting contingencies upon the contractor, because *the Government must then pay for the contingency whether it arises or not*. This is the fundamental principle governing such cases, and there were absolutely too many contingencies at Panama to permit the work by contract.

But there are other reasons. Your proposition to turn it over to a contractor on the "cost-plus-a-fixed-sum" plan would have been out of the question. The contractor having the job of his life and no other work that could be compared with it, could have employed all his friends and their "sisters and cousins and aunts" on the job at fancy salaries, and the cost could have been made and probably would have been made a pyrotechnic display as bad as that set up by De Lesseps and his assistant.

Supposing, on the other hand, it had been let at unit prices, there was nothing to guide anyone as to what those prices should be. If the contractor had taken the Commission's estimates, he would simply have gone broke. If on the other hand, he put in his own price and included the contingencies, as any sensible contractor must, the bill that the Government would have paid for contingencies would probably have been larger than the bill for constructing the Canal, and many of these contingencies would have been paid for unnecessarily, as they would not have arisen.

Supposing the contract had been divided up among a number of contractors, there was the above mentioned "pyramid" of plant for which the Government paid a large slice of the forty millions to the French company. It would have been a tremendous waste not to have utilized this. It would have to be divided equitably among the several contractors. Who could have made such a division? Nothing but months of actual trial could have enabled anyone to get their bearings on this subject. There were locomotives and pump cars innumerable, possibly useless, possibly valuable, excavators galore that could have been used in some places to advantage but not in others. There were fine steel dredges sunk in the river or perched upon hill tops. What contractor could have bid intelligently on their use or what engineer could have assigned the various machines to the various contracts with any degree of final economy?

Then, there was the Panama Railroad. A number of contractors along the Pennsylvania lines can do their work and get

their supplies from the railroad without affecting its traffic or without interfering with each other in the slightest degree, but the Panama Railroad while necessary as a transcontinental line would at the same time have been swamped in keeping the contractors supplied with what they had a right to have; with transporting the spoil from the various excavations, etc., and it would have been utterly impossible for any supervision to have done justice or at least have given satisfaction to the various contractors on the work, and favoritism that could not have been proven, might have ruined one contractor and made another a millionaire; a contingency bound to be represented in the bids.

Your proposition to have the Commission as a Board of Directors and then have engineers supervise the contracts, as railroads do, is also, I think, untenable. The only duties you specify for such a Board is that they should "receive the reports" of the various departments and perform the various functions belonging to a Board of Directors." This is vague, and the plan was tried in the earlier stages of the work. The Commissioners who were not engineers simply "went along" with those who were, and these latter not being in actual charge of the work must have greatly hampered the chief engineer by ideas derived from experience along totally different lines, not in the tropics. As it is, the work is divided up among the various Commissioners. The statesmen govern the Zone, the doctor heads the Sanitary Department, and the engineers build the Canal. In this connection, by the way, is it not a fact that most contractors for great works have an engineer as the actual executive, and is not that exactly what we have now on the Canal without the contractor?

The above division results in efficiency in each department, and the various heads meet together as a Commission to secure harmony and economy where their various functions overlap. It is a slightly clumsy arrangement unless the personnel is exceptional, but that seems to have been wholly overcome by the fact that the present personnel is exceptionally good.

One deplorable result of your editorial is to cause people to reason that if the lock canal is to cost as much as the estimate of a sea level canal, it would have been better to have built the sea level canal in the first place, and there is much misguided agitation on this point among the "literary engineers" who write some of the remarkable editorials that are appearing in the daily press. I will not take your space in this communication to show that an attempt to build a sea level canal at Panama would have been the monumental engineering blunder of the ages, but I hope to take time in the near future to do this.

Meantime, it should be noted that unless you can show better than you have so far actual extravagance on the part of the

Commission, it is safe to assert that the proportionate cost of the two types of canal would be the same, and if the estimate for the lock canal has to be increased by fifty per cent., the estimate for a sea level canal must be similarly increased. The real problem of the Panama Canal is the crossing of the Chagres River, and there is no feasible way of doing it except by converting its lower portion into a great lake, so that as a river it disappears entirely. In short, I think you and your readers can rest assured that the Panama Canal, is now being constructed in the right way, by the right men, and under the right plan.

Very truly yours,

CASSIUS E. GILLETTE.

Dec. 18, 1908. Land Title Bldg., Philadelphia, Pa.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 1027. **Graphite Productions.**—Joseph Dixon Crucible Co., Jersey City, N. J.

This well known firm's graphite crucibles, lubricants, paint, electrical specialties, electrotyping compounds, polishes, belt dressings and pencils are described and catalogued in this 48-page pamphlet.

No. 1028. **Railway Snow Plow.**—The O. F. Jordan Co., Chicago, Ill.

This large 4-page circular describes in some detail the construction and operation of the combined pneumatic snow plow and spreader built by the firm named for railway use. Some records of work are given.

No. 1029. **Culverts.**—Klauer Mfg. Co., Du-buque, Ia.

This circular describes briefly the construction and characteristics of the galvanized, corrugated culverts made by the firm named. Price lists are given.

No. 1030. **Concrete Coke Ovens.**—The Crawford Paving Co., Pittsburg, Pa.

This is a very interesting 20-page pamphlet describing and illustrating the construction of beehive coke ovens for the Vinton Colliery Co., Vintondale, Pa. Concrete and Simplex concrete piling were used in the construction. Views of the work are shown and a general description of the construction methods is given.

No. 1031. **Downie Deep Well Pumps.**—Keystone Driller Co., Beaver Falls, Pa.

In this 60-page pamphlet the makers describe and illustrate fully the Downie conical valve and discuss its advantages. A large amount of general information is given about deep well pump construction and operation. In addition there are full catalog data on pumps, pump fillings and supplies, and pumping outfits.

No. 1032. **Hoisting Engines.**—National Hoisting Engine Co., Harrison, N. J.

This catalog lists engines and hoists of various kinds and patterns. All machinery is built on the duplicate part system.

No. 1033. **Concrete Piles.**—Simplex Concrete Piling Co., Philadelphia, Pa.

The Simplex concrete pile is constructed by driving a steel shell and withdrawing it as the hole is filled with concrete. This pamphlet of 86 pages describes the apparatus used, the methods of construction and gives results of tests and experience. Views are shown of excavated piles, of pile foundations and of numerous structures founded on concrete piles.

No. 1034. **Scales.**—Standard Scale & Supply Co., Chicago, Ill.

This is a complete catalog of scales of all kinds. The company also handles the Cripp-Concrete Mixer.

CONTRACT NEWS

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We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
Dec. 30. Indianapolis, Ind.	Dec. 23
Jan. 1. Handsboro, Miss.	Dec. 23
Jan. 1. Newport, Ore.	Dec. 16
Jan. 2. Grand Island, Neb.	Dec. 23
Jan. 4. Sandusky, O.	Dec. 23
Jan. 4. Meridian, Miss.	Dec. 30
Jan. 4. Creston, Ia.	Dec. 30
Jan. 4. Salinas, Cal.	Dec. 30
Jan. 5. Fairport, N. Y.	Dec. 16
Jan. 5. Grenada, Miss.	Dec. 23
Jan. 5. Stockton, Cal.	Dec. 23
Jan. 5. Fargo, N. D.	Dec. 30
Jan. 5. Valparaiso, Ind.	Dec. 30
Jan. 5. Albany, N. Y.	Dec. 30
Jan. 6. Granite Falls, Minn.	Dec. 23
Jan. 7. Aberdeen, S. Dak.	Dec. 23
Jan. 8. Salt Lake City, Utah.	Dec. 9
Jan. 8. Cincinnati, O.	Dec. 23
Jan. 8. Cincinnati, O.	Dec. 23
Jan. 8. Cincinnati, O.	Dec. 23
Jan. 8. East Cleveland, O.	Dec. 30
Jan. 9. Sulphur, Okla.	Dec. 30
Jan. 9. Wichita, Kan.	Dec. 30
Jan. 11. Newark, O.	Dec. 23
Jan. 11. Minneapolis, Minn.	Dec. 23
Jan. 12. Geneva, Neb.	Dec. 16
Jan. 12. Rensselaer, Ind.	Dec. 16
Jan. 12. Augusta, Ga.	Dec. 23
Jan. 12. York, Neb.	Dec. 23
Jan. 13. Kearney, Neb.	Dec. 30
Jan. 16. Dayton, Ohio	Dec. 30

Buildings.

Dec. 30. Moultrieville, S. C.	Dec. 9
Dec. 30. Vernon, B. C.	Dec. 16
Dec. 31. Fort Howard, Md.	Dec. 9
Jan. 2. Boston, Mass.	Dec. 23
Jan. 4. Sault Ste. Marie, Mich.	Nov. 25
Jan. 4. Lisbon, O.	Dec. 9
Jan. 4. Chickasha, Okla.	Dec. 30
Jan. 4. Sioux City, Ia.	Dec. 30
Jan. 4. San Francisco, Cal.	Dec. 30
Jan. 5. Niles, Mich.	Nov. 25
Jan. 5. Frankfort, Ky.	Dec. 9
Jan. 5. New York, N. Y.	Dec. 23
Jan. 5. Clariton, Pa.	Dec. 30
Jan. 6. Paris, Ill.	Dec. 9
Jan. 6. Fort Slocum, N. Y.	Dec. 9
Jan. 6. Fort Myer, Va.	Dec. 16
Jan. 6. Pittsburg, Pa.	Dec. 30
Jan. 6. Canastota, N. Y.	Dec. 30
Jan. 6. Baltimore, Md.	Dec. 30
Jan. 7. Johnson City, Tenn.	Dec. 9
Jan. 8. Stillwater, Okla.	Dec. 16
Jan. 8. Stillwater, Okla.	Dec. 30
Jan. 9. Murfreesboro, Tenn.	Dec. 9
Jan. 9. Key West, Fla.	Dec. 23
Jan. 9. Washington, D. C.	Dec. 23
Jan. 11. Gainesville, Fla.	Dec. 16
Jan. 12. Warren, O.	Dec. 16
Jan. 12. Fort Rosecrans, Cal.	Dec. 30
Jan. 15. Carthage, Mo.	Dec. 30
Jan. 18. Fort Meade, S. Dak.	Dec. 23
Jan. 19. San Jose, Cal.	Dec. 30
Jan. 20. Springfield, Mass.	Dec. 23
Jan. 20. Fort Robinson, Neb.	Dec. 30
Jan. 21. Fort Crook, Neb.	Dec. 30
Jan. 23. Anderson, S. C.	Dec. 30
Jan. 23. Portland, Me.	Dec. 23
Feb. 4. San Antonio, Texas.	Dec. 30

Roads and Streets.

Dec. 30. Chambersburg, Pa.	Dec. 16
Dec. 30. Greensburg, Pa.	Dec. 16
Dec. 30. Hobart, Okla.	Dec. 23
Dec. 30. Long Island (L. I.), N. Y.	Dec. 23
Dec. 30. Brooklyn, N. Y.	Dec. 23
Dec. 30. Indianapolis, Ind.	Dec. 23

Dec. 30. Bluffton, Ind.	Dec. 23
Dec. 31. Kansas City, Mo.	Dec. 16
Dec. 31. Uniontown, Pa.	Dec. 16
Dec. 31. Kansas City, Mo.	Dec. 23
Dec. 31. Kokomo, Ind.	Dec. 23
Dec. 31. Delhi, Ind.	Dec. 23
Jan. 1. Humboldt, Tenn.	Dec. 23
Jan. 2. Griffith, Md.	Dec. 16
Jan. 4. Mt. Pleasant, Mich.	Dec. 23
Jan. 4. Williamsport, Ind.	Dec. 23
Jan. 4. Tipton, Ind.	Dec. 23
Jan. 4. Terre Haute, Ind.	Dec. 23
Jan. 4. Rushville, Ind.	Dec. 23
Jan. 4. Huntington, Ind.	Dec. 23
Jan. 4. Hartford City, Ind.	Dec. 23
Jan. 4. Greenfield, Ind.	Dec. 23
Jan. 4. Columbus, Ind.	Dec. 23
Jan. 4. Sioux Falls, S. D.	Dec. 30
Jan. 4. Fowler, Md.	Dec. 30
Jan. 5. Washington, Ind.	Dec. 23
Jan. 5. Wabash, Ind.	Dec. 23
Jan. 5. Tipton, Ind.	Dec. 23
Jan. 5. Sullivan, Ind.	Dec. 23
Jan. 5. Lebanon, Ind.	Dec. 23
Jan. 5. Covington, Ind.	Dec. 23
Jan. 5. Brownstown, Ind.	Dec. 23
Jan. 5. New Castle, Ind.	Dec. 30
Jan. 6. Muncie, Ind.	Dec. 23
Jan. 6. Madison, Ind.	Dec. 23
Jan. 6. Charleston, W. Va.	Dec. 30
Jan. 6. Pittsburg, Pa.	Dec. 30
Jan. 7. Vicksburg, Miss.	Dec. 30
Jan. 12. Rockville, Md.	Dec. 23
Jan. 14. Flemington, N. J.	Dec. 23
Jan. 16. Cleveland, O.	Dec. 30
Jan. 18. Pensacola, Fla.	Dec. 23
Feb. 1. Olympia, Wash.	Dec. 23
Feb. 11. Appleton, Wis.	Dec. 30

Sewers.

Dec. 30. Louisville, Ky.	Dec. 16
Jan. 4. Wilkinsburg, Pa.	Dec. 30
Jan. 6. Winchester, Ind.	Dec. 23
Jan. 6. Charleston, W. Va.	Dec. 30
Jan. 6. Pittsburg, Pa.	Dec. 30
Jan. 7. Erie, Pa.	Dec. 16
Jan. 8. Valparaiso, Ind.	Dec. 23
Jan. 8. Salt Lake City, Utah.	Dec. 30
Jan. 13. Polk, Pa.	Dec. 23
Jan. 14. Danville, Pa.	Dec. 23
Jan. 19. East Point, Ga.	Dec. 30

Water Supply.

Dec. 31. Oakville Ont.	Dec. 23
Jan. 2. Louisville, Ky.	Dec. 23
Jan. 5. Leesburg, Fla.	Dec. 23
Jan. 5. Jamestown, Okla.	Dec. 30
Jan. 5. Clinton, Okla.	Dec. 30
Jan. 5. E. Grand Forks, Minn.	Dec. 30
Jan. 12. Connorsville, Ind.	Dec. 2
Jan. 19. East Point, Ga.	Dec. 30

Miscellaneous.

Dec. 30. Columbus, O.	Laying Track, Etc., Dec. 23
Dec. 31. Cairo, Ill.	Garbage Removal, Dec. 30
Jan. 4. Hartford, Conn.	Street Lightning, Nov. 18
Jan. 4. Galveston, Texas.	Metal Work, Dec. 16
Jan. 4. Tennesse, N. S.	Breakwater Extension, Dec. 23
Jan. 4. Portsmouth, Va.	Garbage Incinerator, Dec. 30
Jan. 4. Los Angeles, Cal.	Hauling, Dec. 30
Jan. 5. Boston, Mass.	Refuse Disposal, Dec. 16
Jan. 6. West Union, Ia.	Celk, Dec. 16
Jan. 6. Highland Park, Va.	Electric Plant, Dec. 30
Jan. 7. Kingston, Ont.	Masonry, Concrete Piles, Etc.
Jan. 7. Portsmouth, O.	Street Lighting, Dec. 23
Jan. 7. New York, N. Y.	Pressure Tunnel, Dec. 23
Jan. 11. Albany, Minn.	Lighting System, Dec. 30
Jan. 12. New York, N. Y.	Fencing, Dec. 30
Jan. 15. Ottawa, Ont.	Steamer, Dec. 2
Jan. 20. Boston, Mass.	Refuse Disposal, Dec. 30
Jan. 21. Detroit, Mich.	Wooden Tug, Dec. 30
Feb. 13. Hawaii, ...	Dry Dock, Dec. 9

Excavation, Earth and Rock

Jan. 1. Rosbud, Texas.	Excavation, Dec. 30
Jan. 2. St. Paul, Minn.	Ditch Work, Dec. 23
Jan. 2. St. Paul, Minn.	Ditch Work, Dec. 30
Jan. 6. Houston, Texas.	Ditch Work, Dec. 23

Jan. 9. Anoka, Minn.	Ditch Work, Nov. 25
Jan. 9. Houston, Texas.	Drainage Work, Dec. 16
Jan. 9. Delphia, Ind.	Drain, Dec. 23
Jan. 9. Anoka, Minn.	Ditch Work, Dec. 30
Jan. 15. Mobile, Ala.	Dredging, Dec. 23
Jan. 15. Mangum, Okla.	Railroad Grading, Dec. 16
Jan. 16. Goshen, Ind.	Ditch, Dec. 30
Jan. 18. Bayou Goula, La.	Dredging, Dec. 30
Jan. 18. Des Moines, Ia.	Ditch Work, Dec. 30
Jan. 23. New London, Conn.	Dredging, Dec. 30

Materials, Machines, Supplies, Tools, Etc.

Dec. 30. Chicago, Ill.	Lumber, Dec. 30
Dec. 31. Washington, D. C.	Powder Holsts, Dec. 9
Jan. 4. Fort Monroe, Va.	Engines, Boilers, Etc., Dec. 9
Jan. 4. Washington, D. C.	Steel, Iron, Drills, Etc., Dec. 16
Jan. 4. Virginia, Minn.	Fire Engine, Dec. 30
Jan. 4. Los Angeles, Cal.	Pump Engines, Dec. 30
Jan. 4. Mont Alto, Pa.	Gas Generators, Dec. 30
Jan. 7. Kansas City, Mo.	Boilers, Dec. 30
Jan. 7. Duluth, Minn.	Pipe, Dec. 30
Jan. 8. Fort Leavenworth, Kan.	Ballast, Dec. 30
Jan. 8. Minneapolis, Minn.	Water Pipe, Etc., Dec. 30
Jan. 11. Washington, D. C.	Cables, Pulleys, Etc. Dec. 30
Jan. 14. Kansas City, Kan.	Water Pipe, Etc., Dec. 30
Jan. 15. Portland, Ore.	Portland Cement, Dec. 2
Jan. 18. Washington, D. C.	Sanitary Fixtures, Pipe, Etc.
Jan. 19. East Point, Va.	Pump, Generator, Boilers, Etc.
Jan. 21. Fort Dodge, ...	Gymnasium Apparatus, Dec. 30
Jan. 25. North Vancouver, B. C.	Road Machinery, Dec. 23
Jan. 26. Frankfort, Ky.	Filing Cases, Dec. 30
Feb. 22. Winnipeg, Man.	Pump, Motor, Dec. 9

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Salinas, Cal.—Until 10 a. m., Jan. 4, by T. P. Joy, Clerk County Supervisors, for a combined automatic sluice gate and highway bridge on Elkhorn Slough near Hudson's Landing in Pajaro Road District.

Creston, Ia.—Until Jan. 4, by W. F. Craig, County Auditor, for furnishing material and constructing all bridges ordered by the County Commissioners during 1909.

Valparaiso, Ind.—Until Jan. 5, by S. P. Corboy, County Auditor, for erection of a bridge in Portage Township.

Wichita, Kan.—Until noon, Jan. 9, by County Commissioners, for constructing five new bridges as follows: Steel bridge 80 ft. long, over Spring Creek in Rockford Township, estimate \$2,000; steel bridge, 80 ft. long, over Spring Creek in Morton Township, estimate \$2,000; steel bridge, 80 ft. long, over Cowskin Creek in Delano Township, estimate \$2,000; steel bridge over the Arkansas River on Lawrence Avenue, in section 5, between Gypsum and Waco Townships, to use the steel formerly used on the Douglas Avenue bridge, estimate \$9,000; steel bridge, 40 ft. long, across Chisholm Creek in Wichita Township, estimate \$1,100.

Meridan, Miss.—Until 2 p. m., Jan. 4, by W. R. Pistole, Chancery Clerk, for constructing wooden bridge over Ponta Creek on John K. Mosby Road. Also for a wooden bridge over Okatibika Creek on the Dahlgren Road.

Albany, Mo.—Until Jan. 5, by W. A. Henton, County Surveyor, for constructing eleven 30-ft. I-beam bridges on steel legs, six 24-ft. I-beam bridges on steel legs and one 70-ft. span on tubs.

Fargo, N. Dak.—Until noon Jan. 5, by Arthur G. Lewis, County Auditor, for the

remodeling of the laboratory at Herron Hill pumping station, with appurtenances.

Anderson, S. C.—Until 3 p. m., Jan. 23, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction complete (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. Post Office and Court House at Anderson, S. C.

San Antonio, Tex.—Until 3 p. m., Feb. 4, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (complete) of the extension to the U. S. Post Office and Court House at San Antonio, Tex.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

New Castle, Ind.—Until 10 a. m., Jan. 5, by W. L. Risk, County Auditor, for constructing two mile gravel road in Fall Creek Township; also for constructing public highway north of Cadiz.

Fowler, Ind.—Until noon, Jan. 4, by Lemuel Shipman, County Auditor, for constructing two gravel roads of a total length of five miles.

Vicksburg, Miss.—Until Jan. 7, by J. D. Laughlin, Chancery Clerk, for construction of a road leading from city limits at east end of Clay St. to Confederate Ave. in Vicksburg National Military Park.

Cleveland, O.—Until 11 a. m., Jan. 16, by County Commissioners, William F. Black, Clerk, for the grading, draining and improving of Center Road No. 2 from Miles Ave. at Randall to Bedford Road in Bedford Village, in Warrensville and Bedford Townships.

Pittsburg, Pa.—Until 10 a. m., Jan. 6, by A. B. Shepherd, Director Public Works, for grading, curbing and paving with blockstone on Labelle St., and for grading, curbing and paving with repressed vitrified brick on Zenith Alley.

Sioux Falls, S. Dak.—Until 8 p. m., Jan. 4, by W. A. Cornell, City Auditor, for grading portions of several streets.

Charleston, W. Va.—Until Jan. 6, by Board of Affairs, W. A. Hogue, City Engineer, for grading, curbing and paving several streets. Estimated cost of work is \$210,000.

Appleton, Wis.—Until 5 p. m., Feb. 1, by Board Public Works, E. L. Williams, City Clerk, for paving part of Washington St. with crosstied wood block in concrete.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

East Point, Ga.—Until Jan. 19, by J. C. McKenzie, Mayor, for constructing about 12 miles of sewers. E. H. Davis, Engineer, Griffin, Ga. See also under Bids Asked—Water Supply.

Pittsburg, Pa.—Until 10 a. m., Jan. 6, by A. B. Shepherd, Director Public Works, for constructing 9-in. and 12-in. pipe sewer in Middletown St.

Wilkesburg, Pa.—Until 3 p. m., Jan. 4, by Freese & Sperling, Borough Engineers, Carl Bldg., Wilkesburg, for the construction of 420 ft. of 15-in. storm sewer on South Ave. from Wood St. eastwardly and 70 sq. yds. of vitrified brick paving with a concrete base and cement filler in culvert under Wood St.

Salt Lake City, Utah.—Until 8 p. m., Jan. 8, by Board Public Works, L. C. Kelsey, City Engineer, for constructing pipe sewers in Sewer Extension No. 219.

Charleston, W. Va.—Until Jan. 6, by Board of Affairs, W. A. Hogue, City Engineer, for constructing sewers in several streets. Estimated cost is \$30,000.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

East Grand Forks, Minn.—Until 3 p. m., Jan. 5, by C. P. Zimmerman, City Clerk, for furnishing and installing a pumping plant for the city water system. Bids will be received on steam and electric pumping plants. Loweth & Wolff, Engineers, St. Paul, Minn.

East Point, Ga.—Until Jan. 19, by J. C. McKenzie, Mayor, for excavating and building reservoir 75 ft. x 10 ft., digging one or two 6-in. and 8-in. wells, building pump station and for furnishing and erecting the

following. 150-hp. boiler, 72x18, and stack; two 750,000-gallon capacity in 24 hours compound duplex pumps, one boiler-feed pump, one 125-hp. direct-connected four-valve engine, one air compressor and receiver, 70 fire hydrants, 49 flush tanks, 70 tons cast-iron pipe and specials, one 100-kwt. alternating generator, direct connected, revolutions 290 per minute; 25 arc lamps and regulator, pole lines, switchboards and feeder panels, including all instruments. Bids are also asked for building about 12 miles sewerage. E. H. Davis, Engineer, Griffin, Ga.

Clinton, Okla.—Until Jan. 5, by Mayor V. F. Carleton, for furnishing all tools, labor and material necessary for about 40 blocks' extension to distributing system of water works. J. L. O'Hearn, City Engineer.

Jamestown, N. Dak.—Until 3 p. m., Jan. 4, by G. E. Lyman, City Engineer, for constructing well approximately 40 ft. deep and 16 ft. in diameter. Sam Crabbe, Engineer, Fargo, N. Dak.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

New London, Conn.—Dredging.—Until noon, Jan. 23, by Mayor Harry Taylor, U. S. Engineer, for dredging in Bridgeport Harbor.

Des Moines, Ia.—Ditch Work.—Until noon, Jan. 18, by Lew W. Burnett, County Auditor, for constructing ditch in District No. 6, requiring about 37,420 cu. yds. of excavation.

Goshen, Ind.—Ditch.—Until 10 a. m., Jan. 16, by County Commissioners, for the construction of the Karn Ditch in Jefferson Township. Vernon Krider, Commissioner.

Bayou Goula, La.—Dredging.—Until Jan. 18, by J. W. Supple, President Bayou Tigris Drainage District, for excavating and dredging 250,000 cu. yds. of dirt in Bayou Tigris Drainage District near Bayou Goula.

Anoka, Minn.—Ditch Work.—Until 11 a. m., Jan. 9, by A. A. Caswell, County Auditor, for Ditch No. 49, requiring 83,000 cu. yds. of excavation. Ditch is to be 2 ft. to 6 ft. wide on the bottom and from 10 ft. to 19 ft. on the top.

St. Paul, Minn.—Ditch Work.—Until 11 a. m., Jan. 2, by State Drainage Commission, for constructing State Ditch No. 63, known as Blind Lake State Ditch, consisting of one main ditch and one lateral. The work requires 85,286 cu. yds. of excavation and is suitable for floating dredge construction.

Rosebud, Tex.—Excavation.—Until Jan. 1, by S. J. Ward, Mayor, for excavation of about 25,000 cu. yds. of dirt for water works reservoir.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Los Angeles, Cal.—Hauling.—Until 11 a. m., Jan. 4, by Board Public Works, Horace B. Ferris, Secretary, for the hauling of material and freight for use in the Los Angeles Aqueduct.

Cairo, Ill.—Garbage Removal.—Until 5 p. m., Dec. 3, by Ernest Nordmann, City Comptroller, for removal of garbage for ensuing year.

Boston, Mass.—Refuse Disposal.—Until noon, Jan. 20 (extensive from Jan. 5), by Guy C. Emerson, Superintendent of Streets, for the erection and operation on the property of the city, at Fort Hill Wharf, of a plant for the disposal by incineration of portions of the combustible waste, to be separated from city refuse, delivered at the plant.

Detroit, Mich.—Wooden Tug.—Until 3 p. m., Jan. 21, by Lt. Col. C. McD. Townsend, U. S. Engrs., for building and furnishing wooden tug.

Albany, Minn.—Lighting System.—Until 8 p. m., Jan. 11, by Thos. Tomasek, Village Recorder, for furnishing materials and for furnishing a village lighting system. Edmund T. Sykes, Engineer, of Minneapolis, Minn. Electric light and acetylene gas light will be considered; prime movers may be gasoline, producer gas or oil engines. An approximate capacity of 600 16-cp. lights or equivalent is desired.

New York, N. Y.—Fencing.—Until noon, Jan. 12, by the Aqueduct Commissioners, 280 Broadway, New York for building 2½ miles of iron and wooden fencing around Jerome Park reservoir. The work includes the following: Iron fencing, 6 ft. high, 8,520 ft.; iron fencing, 4 ft. high, 3,180 ft.; wooden fencing, 6 ft. high, 4,165 ft.; iron gates, 15; wooden gates, 6; granite gate posts, 10; concrete, 225 cu. yds.; rock excavation, 500-

bridge work. Construction is to be on bridge between sections 25 and 36, A1, on Township. Repair Bridge on line between sections 3 and 10, Cornell Township, to be replanked. Also bridge on line between sections 28 and 33, Hill Township, to be replanked and otherwise repaired.

Kearney, Neb.—Until Jan. 13, by E. A. Miller, County Clerk, for the construction of all bridges and bridge repair work to be built in Buffalo County during 1909.

Rochester, N. Y.—Until noon, Jan. 5 (Re-advertisement), by E. C. Stevens, State Superintendent of Public Works, Albany, N. Y., for constructing lift bridge over the Erie Canal at Allen St.

Sulphur, Okla.—Until 2 p. m., Jan. 9, by A. R. Green, Superintendent of National Park, Sulphur, Okla., for constructing steel bridge over Rock Creek.

Dayton, O.—Until 11 a. m., Jan. 16, by T. J. Kaufman, County Auditor, for constructing sub and superstructure of bridge over Miami River on the line between Harrison and Madison Townships. Substructure work will include two abutments and two piers.

East Cleveland, O.—Until Jan. 9, by K. F. Lee, Village Clerk, 326 Williamson Bldg., Cleveland, for furnishing material and constructing a 24-in. circular culvert, in certain parts of the village. Please Engineering Co., 931 Williamson Bldg., Cleveland, Engineers.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Fort Rosecrans (P. O., San Diego), Cal.—Until Jan. 12, by Earl McFarland, Constructing Q. M., for construction of two double sets of non-commissioned officers' Quarters at Fort Rosecrans.

San Francisco, Cal.—Until Jan. 4, by Board Public Works, for the general construction work to be done on the new Bryant Cosmopolitan School. The building will cost \$100,000.

San Jose, Cal.—Until Jan. 19, by Dr. M. E. Dailey, President State Normal School, for erection of new normal school buildings to take the place of those destroyed by the earthquake. Plans, etc., in State Engineer's office, Sacramento, Cal.

Sioux City, Ia.—Until 4 p. m., Jan. 4, by Oscar J. Hoberg, Chairman School House Committee, for the erection and completion of a 10-room, brick school building upon the grounds of the Dr. Wm. R. Smith school. Reinecke & Jenkinson, Architects, 406 United Bank Bldg., Sioux City, Ia. Separate bids for the heating, lighting, ventilating and plumbing of said building will also be received at the same time.

Baltimore, Md.—Until 11 a. m., Jan. 6, by Edward D. Preston, Inspector of Buildings, for the erection of a truckhouse at the southeast corner of Calvert and Read Sts., for the City Fire Department.

Carthage, Mo.—Until Jan. 15, by J. G. Armitage, Chairman Building Committee, for the erection of the Christian church at this city.

Fort Crook, Neb.—Until 11 a. m., Jan. 21, by Capt. Joseph F. Gohn, Constructing Q. M., for constructing one brick stable and one brick bakery, and for installing plumbing, steam heating, electric wiring and electric fixtures in buildings specified.

Fort Robinson, Neb.—Until 1 p. m., Jan. 20, by Capt. F. T. Arnold, Constructing Q. M., for all material and labor required in the construction of additions to the post hospital Fort Robinson; also for heating, plumbing and electric wiring in same.

Canastota, N. Y.—Until 6 p. m., Jan. 6, by Board of Education, D. S. Watson, President, for the mason, carpenter, painting and lighting, also for heating and ventilating work, needed in remodeling and building and completing an addition to the present High School building of Union Free School, District No. 9.

Chickasha, Okla.—Until Jan. 4, by J. S. Tatman, Secretary Board of Education, for constructing 3-story, 8x130 ft., brick and stone high school building.

Stillwater, Okla.—Until Jan. 8, by W. A. Etherton, for the erection of a boys' dormitory for the Oklahoma Agricultural and Mechanical College.

Clinton, Pa.—Until 1 p. m., Jan. 5, at office of Charles J. Rieger, Architect, Room 1202 Peoples' Savings Bank Building, 307 Fourth Avenue, Pittsburg, Pa., for the erection of a 12-room school building to be erected on lot situated at the corner of Summit St. and Shaw Ave., in the borough of Clinton, Pa.

Pittsburg, Pa.—Until 10 a. m., Jan. 6, by A. B. Shepherd, Director Public Works, for

cu. yds.; earth excavation, 500 cu. yds.; earth filling, 4,500 cu. yds.

Highland Park (P. O. Richmond), Va.—Electric Plant.—Until Jan. 6, by Mayor W. P. Redd, 1114 East Main St., Richmond, for a 10-year franchise for electric light and power system here.

Portsmouth, Va.—Garbage Incinerator.—Until 8 p. m., Jan. 4, by Street Committee, E. B. Hawkes, Chairman, for furnishing all necessary materials and erecting complete an incinerator, or crematory, with a daily destructive capacity of 25 tons of wet and dry garbage. Plans and specifications for the completed plant must accompany the bid.

Materials, Machines, Supplies, Tool, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Los Angeles, Cal.—Pumps, Engine.—Until Jan. 4, by Water Commissioners for furnishing a horizontal 6-cylinder duplex double-acting condensing steam pump, a 65-hp. multi-cylinder distillate engine, and a single-acting crosshead guided triplex power pump.

Washington, D. C.—Cable, Pulleys, Etc.—Until 10:30 a. m., Jan. 11, by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing, under Circular No. 485, repair parts for cars, wire cable, iron conduit, electric cable, wire joints, sand drier, pulleys, pipe covering, etc.

Washington, D. C.—Sanitary Fixtures, Pipe, Etc.—Until 10:30 a. m., Jan. 18, by Capt. F. C. Boggs, General Purchasing Officer, Isthmian Canal Commission, for furnishing, under Circular No. 486, sanitary fixtures, sheet brass, brass pipe and fittings, iron pipe and fittings, cocks, bibbs, valves, lead pipe, wheels, axles, wagon parts, tire wheel and shrinker, axle gauge, punch and shear, bolt cutter, locomotive ash pan, studs, anchors, chain, windlasses, marine lights, Marine, asbestos cement, engine oil, etc.

Fort Dade, Fla.—Gymnasium Apparatus.—Until 8 p. m., Jan. 21, by Constructing Q. M., for furnishing and installing gymnasium apparatus at the gymnasium at this post.

East Point, Ga.—Pump, Generators, Boilers, Etc.—See under Bids Asked—Water Supply.

Chicago, Ill.—Lumber.—Until 11 a. m., Dec. 30, by Department Public Works, 200 Randolph St., for furnishing lumber for various departments for ensuing year.

Frankfort, Ky.—Filing Cases, Etc.—Until Jan. 26, by Board of State Capitol Commissioners, Edw. M. Drane, Secretary, Frankfort, Ky., for furnishing and installing metal file cases and library equipment in new State Capitol. Frank M. Andrews & Co., Architects, Waldorf-Astoria, New York City.

Duluth, Minn.—Pipe.—Until 4 p. m., Jan. 7, by Water and Light Commissioners, for furnishing cast iron water and gas pipe.

Minneapolis, Minn.—Water Pipe, Etc.—Until Jan. 8, by L. A. Lydeard, City Clerk, for furnishing cast iron water pipe, hydrants, valves and special castings for the season of 1909.

Virginia, Minn.—Fire Engine.—Until 8 p. m., Jan. 4, by A. E. Brickford, City Clerk, for supplying a first size steam pipe engine of 900-gallon capacity.

Fort Leavenworth, Kan.—Ballast.—Until 11 a. m., Jan. 8, by Capt. Wm. D. Davis, Constructing Q. M., for furnishing and delivering in good condition f. o. b. cars, freight prepaid, 1,200 cu. yds., ballast for U. S. Railway Terminals at Fort Leavenworth, Kan.

Kansas City, Mo.—Boilers.—Until 2 p. m., Jan. 7, by Fire and Water Commissioners, S. J. Armstrong, Secretary, for furnishing all labor and material necessary to install, construct and equip four 350-hp. boilers with oil burners. The same to be constructed in accordance with the best practice for using crude or fuel oil.

Kansas City, Mo.—Water Pipe, Etc.—Until 2 p. m., Jan. 14, by Fire and Water Commissioners, S. J. Armstrong, Secretary, for furnishing and delivering f. o. b. open cars, Kansas City, all the pipe and specials required for the city's use for the twelve months ending Jan. 1, 1910. The following schedule shows the estimated quantities of pipe and specials that will be required: 36-in. Class D pipe, 1.58-in. metal, 837 tons; 30-in. Class D pipe, 1.37 in. metal, 1,454 tons; 24-in. Class C pipe, 1.04 in. metal, 1,593 tons; 20-in. Class C pipe, .92 in. metal, 170 tons; 16-in. Class C pipe, .80 in. metal, 2,840 tons; 12-in. Class C pipe, .68 in. metal, 1,311 tons; 10-in. Class C pipe, .62 in. metal, 15 tons; 8-in. Class C pipe, .56 in. metal, 150 tons; 6-in. Class C pipe, .51 in. metal, 100 tons; also about 250 tons specials required.

Mont Alto, Pa.—Gas Generators, Etc.—Until 5 p. m., Jan. 4, by Samuel G. Dixon, State Commissioner of Health, 1900 Race St., Philadelphia, for the furnishing of all labor and material necessary for the construction of acetylene gas generators, generator houses, etc., for dining building and infirmary, at the Pennsylvania State South Mountain Sanatorium, Mont Alto.

CONTRACTS LET.

The following contracts have been let recently:

Denver, Colo.—Grading, Curbing, Etc.—Denver & Pueblo Construction Co., Denver, at \$206,000, for grading, curbing, etc., in Capitol Hill Improvement Districts Nos. 5 and 6, for city.

Denver, Colo.—Canal Work.—Phillips & O'Gara Construction Co., Denver, Colo., for enlarging canal of Denver Reservoir Irrigation Co. Estimated cost is about \$100,000.

Florence, Colo.—Bridge Work.—Fox & Smith, at \$6,489, for constructing two bridges over Sand Creek—one at 2nd St. and the other at 5th St.

Columbus, Ga.—Railroad Work.—Hall & Parker, Macon, Ga., according to reports, for constructing northern extension of the Georgia, Florida & Alabama R. R., from Cuthbert, Ga., to Richland, Ga.

Coeur D'Alene, Idaho.—Bridges.—Carscallen Bros., at \$1,450 and \$1,375, for constructing two wood bridges for county.

Quincy, Ill.—Bridge.—Van Dusen & Turner, Keokuk, Ia., at \$1,275, for constructing the Niekamp bridge in Melrose Township for the county.

Stonington, Ill.—Tile Work.—John Drohn, Decatur, Ill., at \$4,700, for trenching and laying about 54,000 ft. of 7-in. to 28-in. tile. Contract for furnishing tile was let to Stone-ware Pipe Co., East Alton, Ill., at \$17,600.

Taylorville, Ill.—Ditch Work.—N. C. McGinnis Co., Bement, Ill., at about \$12,000, for constructing 2½-mile ditch.

Anderson, Ind.—Gravel Road.—John B. Mason, Alexandria, Ind., for constructing gravel road for Madison County.

Noblesville, Ind.—Gravel Roads.—Nees & Co., Frankfort, Ind., for construction of 14,756 ft. of gravel road in Hamilton County, at \$12,319; Eli T. Pickard, Kempton, Ind., for 6,765 ft. of gravel roadway in Hamilton County, at \$3,935.

Washington, Ind.—Bridges.—Vincennes Bridge Co., Vincennes, Ind., at about \$6,000, for constructing eight bridges for Daviess County.

Independence, Kan.—Sewer.—Rushmore & Gowdy, Cherryvale, Kan., at \$11,342, for constructing west side sewer for this city.

Louisville, Ky.—Sewer.—T. J. O'Connell, Baltimore, Md., at about \$40,000, for constructing Sec. D. of the Beargrass interceptor. Sewer is to be about 2,000 ft. long.

Baltimore, Md.—Building Work.—The Terminal Warehouse Co. has awarded to J. Henry Miller the contract for building a large addition to its warehouses at Monument, Constitution and Front Sts. known as the Monument Street Stores, including the power house on Front St. The total cost of the plant will exceed \$200,000. The structure was designed by Owens & Sisco, Architects, with Charles L. Reeder as consulting engineer.

Kansas City, Mo.—Asphalt Paving.—Barber Asphalt Paving Co., at \$1.95 per sq. yd., for paving Grauman Ave.

Olean, N. Y.—Bridge.—Canton Bridge Co., Canton, O., at \$7,356, for constructing bridge over Allegheny River at East Olean.

Cleveland, O.—Paving.—Board Public Service is stated to have awarded paving contracts as follows: Roehl Bros., for Ashbury Ave., \$16,537; Bower Ave., \$2,696; Corning Ave., \$4,177; E. 111th St., \$7,638; E. 83d St., \$3,652; Lee Ave., \$7,213; E. 24th St., \$2,061; Lexington Ave., \$2,465. The Cleveland Trinidad Paving Co., Clifton Rd., \$9,489; E. 64th St., \$4,285; Ellen Ave., \$3,501; W. 38th St., \$3,002. Northern Ohio Paving & Construction Co., Arcade Bldg., Eglindale av., \$4,051; E. 51st St., \$8,374; View Rd. and W. 17th St., \$7,740; Rowley Ave., \$4,024; Lansing Ave., \$7,135; Baldwin Bros. & Graham, Rose Bldg., E. 108th St., \$2,288; Wade Park Ave., \$22,461; W. 18th St., \$3,899. M. E. Kavanagh, E. 100th St., \$2,334. Brick will be used in all but one of the contracts.

Cleveland, O.—Wharf.—Great Lakes Dredge & Dock Co., Chicago, Ill., at \$53,735, for constructing wharf at Cleveland Harbor.

East Liverpool, O.—Paving.—Ryan & McLaughlin, East Liverpool, at \$49,000, for grading, curbing and paving of Pennsylvania and Sheridan Aves. Bids for this work were received several weeks ago.

El Reno, Okla.—Bridges.—Kansas City Bridge Co., Kansas City, Mo., for constructing two bridges for Canadian County.

Portland, Ore.—Building Work.—North-west Bridge Works for the concrete and iron work for the building of the Public Market & Cold Storage Co., to be erected at 5th and Gilson, to over the block to Hoyt St.

Lexington, S. C.—Bridge.—Carolina Engineering Co., Burlington, N. C., at \$18,500, for erecting steel bridge over the Saluda River for the county.

Sparta, Tenn.—Bridge.—Nashville Bridge Co., Nashville, Tenn., for constructing bridge over the Caney Fork at Josh's Ferry.

Brownsville, Tex.—Railroad Work.—Hidalgo Construction Co., Hidalgo, Tex., for building 25 miles of railway for the San Antonio & Rio Grande R. R.

San Antonio, Tex.—Railroad Work.—The Asherton R. R. has awarded a contract to the Block-Pollock Co., St. Louis, Mo., for 12 miles of rails to be delivered at Artesia, Tex., by Jan. 15.

Suffolk, Va.—Sewers.—H. M. Macleary & Co., for installing sewers in Charles and Jackson Sts.

Colfax, Wash.—Bridges.—I. J. Bailey & Co., Wenatchee, Wash., at following bids for constructing steel wagon bridges for county: McLean bridge, near Oakesdale, 60 ft., \$1,928; Dowling bridge, Union flat, south of Colfax, 60 ft., \$2,078; Horlacher bridge, Rosalia, 75 ft., \$2,378; Armstrong sliding bridge, 75 ft., \$2,666; Shawnee bridge, east of Colfax, 90 ft., \$3,024; North Latah bridge, near Tekoa, 60 ft., \$1,928; Stipe bridge, west of Colfax, 114 ft., \$4,216; Torrence bridge, near Diamond, 130 ft., \$4,950.

Tacoma, Wash.—Railroad Tunnel.—Hudson & Rydstrom, Tacoma, Wash., at about \$800,000, for constructing the Union Pacific tunnel in Tacoma. The tunnel will be 8,700 ft. long and the earth will be used in fills on the tide flats and the south end. The St. Paul & Tacoma Lumber Co. is stated to have been awarded the contract for the timber.

Spokane, Wash.—Bridge.—Chas. G. Sheely, Denver, Colo., at \$6,576, for building bridge three miles east of city limits for County Commissioners.

Wilton, Wis.—Water Works.—Sweeney Bros., Reedsburg, Wis., for constructing water works for this place.

Sarnia, Ont.—Paving.—Frank Guthridge, at about \$27,000, for paving Front St. with creosoted wood block.

Peterboro, Ont.—Canal Work.—Randolph McDonald, Toronto, Ont., for constructing Sec. No. 7 of the Trent Valley Canal. Mr. R. McDonald also has the Rosedale section. Sec. No. 7 extends from Rice Lake to Healy Falls, a distance of about 20 miles, and includes the construction of a dam and lock at Hastings, new guide piers at the G. T. R. bridge at the same village, and also at the Narrows at Trent Bridge, the dredging of the river from Hastings to Healy Falls to produce a 9-ft. draught.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States

Birmingham, Ala.—Construction of joint bridge over Cahaba River at Caldwell's Bridge is being considered by Jefferson and Shelby Counties.

Sacramento, Cal.—C. G. Sheely, Denver, Colo., at \$2,437, was low bidder for constructing bridge near Amador County line for county supervisors.

San Francisco, Cal.—Northwestern Pacific R. R., W. C. Edes, Chief Engineer, San Francisco, is having surveys made to ascertain cost of connecting Guerneville, Cal., and Duncan's Mill with a broad gauge road. Cost will be about \$100,000 and work includes construction of a bridge over Russian River at Monte Rio.

Bridgeport, Conn. Bids were opened Dec. 15, by the City Bridge Commission, for constructing the Congress St. bridge. All of the bids are stated to have exceeded the estimates of the city. The O'Brien Construction Co., of New York, associated with Toole & Sunderlin, Bridgeport, Conn., are said to have been the lowest bidders, with Snare & Triest, New York, as the next lowest.

Cedar Rapids, Ia.—George D. Dobson, C. E., Des Moines Life Bldg., Des Moines, Ia., has plans under way for two reinforced concrete bridges for parks in this city.

Des Moines, Ia.—John W. Budd, City Engineer, has been instructed to prepare plans for the West 7th St. viaduct.

Dubuque, Ia.—City Council is to again take up matter of building a viaduct over the Milwaukee Ry. tracks.

Sioux City, Ia.—The various railroads interested are reported to be having plans prepared for a steel viaduct at Wall St. J. Y. Skeets is City Engineer.

Indianapolis, Ind.—County Commissioners are to call for bids for constructing new bridge over Fall Creek at Capitol Ave. Bridge is to be a 7 span, concrete steel arch having a 10 ft roadway and two 8-ft sidewalks.

Topeka, Kan.—John P. Rogers, City Engineer, has recommended the construction of a new 100 ft bridge over Soldier Creek at Central Ave.

Topeka, Kan.—Atchison, Topeka & Santa Fe Ry., C. A. Morse, Chief Engineer, Topeka, is to reconstruct its bridge over the Kaw River. Steel has been ordered and reconstruction work will probably be started in February. Present bridge comprises four 150-ft spans.

Lansing, Mich.—City is to call for bids for constructing steel-concrete or a steel bridge over Cedar St.

Muskegon, Mich.—County Supervisors have voted to build a steel bridge over the south channel of the Muskegon River to cost \$2,500.

Mankato, Minn.—County Board and Board of Public Works have practically decided on a location for the proposed second bridge over the Minnesota River.

St. Paul, Minn.—St. Paul Bridge & Terminal Co. has been granted permission by the U. S. Government to construct a bridge at South Park over the Mississippi River. The bridge will be of steel, 600 ft. long, and will have concrete piers. The American Bridge Co., Ambridge, Pa., has the contract.

Billings, Mont.—Commissioners of Yellowstone and Carbon Counties have decided to construct a wagon bridge over the Yellowstone River at Laurel. Bridge will cost about \$17,000.

Clarks, Neb.—Supervisors of Merrick County have been asked to appropriate \$4,000 toward the construction of a bridge over the Platte River at this place. Polk County has appropriated \$4,000 and remainder of necessary amount will be raised by committee of which Walter Chamberlain, Clarks, is a member.

Atlantic City, N. J.—Wetherill & Co., Chester, Pa., owners of the Atlantic City & Suburban Ry., are reported to be considering erecting a trolley bridge over Great Egg Harbor Bay, between Somers Point and Ocean City.

Columbus, O.—The Yawger Construction Co., Indianapolis, Ind., at \$87,819, was low bidder for constructing the substructure of the Mount St. viaduct for the city. The Champion Iron Works, Kenton, O., at \$17,932, was low bidder for the superstructure work. Robert H. Simpson is engineer in charge.

Reading, Pa.—Board Public Works will include an item of \$35,000 in its next year's estimates for constructing a bridge over the Lebanon Valley tracks on Tulpehocken St.

Dallas, Tex.—J. M. Preston, City Engineer, has been preparing plans and specifications for the proposed viaduct over the Trinity and the river bottoms between Dallas and Oak Cliff. The plans call for a reinforced concrete structure, whose total length will be about 3,200 ft. The bridge will cost about \$300,000.

Titusville, Pa.—H. A. Holstein, City Engineer, has been working on plans for a steel bridge in Fleming Road and for reinforced concrete bridges over Trout and Hammond Run.

Green Bay, Wis.—Following bids were received Dec. 14, by this city for constructing a bascule bridge over the Fox River at Walnut St.: Milwaukee Bridge Co., Milwaukee, Wis., \$152,875; Grevling Bros., Green Bay, \$159,950; Chicago Bridge & Iron Works, Chicago, Ill., \$165,000; Adolph Green, Green Bay, \$169,180; Standard Construction Co., Chicago, Ill., \$185,000. W. W. Reed is City Engineer.

Sheboygan, Wis.—Milwaukee Bridge Co., Milwaukee, Wis., has completed plans for a bascule bridge over the river at the foot of Pennsylvania Ave.

Railroads.

Items Arranged Alphabetically by States.

Montgomery, Ala.—Elberta, Mobile & Pensacola R. R., recently incorporated with a nominal capital stock of \$50,000, is reported here as being backed by Louisville & Nashville R. R. interests. It is said that the line will be part of the system of that road, running from the end of its line at Bay Minnette, to the L. & N. holdings in Pensacola. The road will be about 100 miles long.

Pearce, Ariz.—Southern Pacific Ry. is said to be planning to begin construction work

early in the year on an extension of its line from Pearce to Courtland, eight miles, with a probable extension three miles further to Glasgow. F. D. Nauman, Tucson, Ariz., is Resident Engineer.

Denver, Colo.—Syndicate of New York capitalists has been going over Colorado & Southern R. R. with a view to advancing \$10,000,000 to carry out the plans for extending the road into Montana, building the Denver-Cheyenne cut-off and making other improvements. It is reported in Denver that work on extending the road through Wyoming to a connection with the C. M. & St. P. Ry. in Montana will be begun in the spring. H. W. Cowan, Denver, Colo., is Chief Engineer C. & S. Ry.

Grand Junction, Colo.—The construction of a steam road from Grand Junction to the Plateau Valley is proposed. The projected length is 40 miles and George Smith, who is promoting the project, is quoted as saying that necessary funds have been secured and work will be begun in the spring, provided a \$75,000 bonus is raised by residents of the Plateau District.

Bainbridge, Ga.—Georgia, Florida & Alabama R. R., J. C. O'Dell, General Manager, Bainbridge, Ga., is said to be considering extending its line from Cuthbert to Columbus, Ga.

Waukegan, Ill.—Elgin, Joliet & Eastern Ry., A. Montzheimer, Chief Engineer, Joliet, Ill., is reported to be planning to make a number of improvements at Waukegan, the northern terminal of the line. Surveys have been under way for some time.

Clinton, Ill.—The construction of a railroad from a point on the Indiana state line east of Georgetown, Ill., to a connection with the Peoria & Eastern Division of the Cleveland, Cincinnati, Chicago & St. Louis R. R. at Elthian, is proposed by the recently incorporated Clinton, Danville & Peoria R. R. Co. The line will connect the mines of the Oak Hill Coal Co., at Clinton, with the Hammond Coal Co., and Dering Coal Co., at the other terminal. R. K. Hammond, of the Hammond Coal Co., Chicago, Ill., and J. K. Dering, of the Dering Coal Co., Old Colony Bldg., Chicago, Ill., are interested in the road, construction work on which is to be started early in the year, it is said.

Bloomington, Ind.—Chicago, Indianapolis & Louisville Ry., W. A. Wallace, Engineer, 198 Custom House Pl., Chicago, Ill., is having plans drawn for rebuilding its warehouse in Bloomington, destroyed recently by fire. About \$100,000—\$45,000 for the brick or concrete building and the remainder for cinder and coal pits, equipment, etc., will be expended.

Bloomington, Ind.—Bloomington Southern R. R., a spur line of the Indianapolis Southern R. R., has secured right of way and will probably be extended this year from South Bloomington, Ind., to Bedford, Ind. A. S. Baldwin, Park Row, Chicago, Ill., is Chief Engineer of the Indianapolis Southern R. R.

Battle Creek, Mich.—Battle Creek, Coldwater & Southern R. R. has been incorporated with a capital stock of \$450,000 and proposes to construct a steam railroad 128 miles long from Battle Creek, Mich., to Coldwater.

Kalamazoo, Mich.—Grand Trunk Ry., T. T. Irving, Resident Engineer, Detroit, Mich., has been granted franchise at Kalamazoo. According to the terms of the franchise the road must build a line into the city within two years.

Virginia, Minn.—Canadian Northern Ry., T. Turnbull, Assistant Chief Engineer, Winnipeg, Man., is reported to have secured 40 acres of land at Virginia for its terminals in that city.

Hastings, Neb.—St. Joseph & Grand Island Ry., J. Berlingett, General Manager, St. Joseph, Mo., is said to have perfected plans for building the proposed Hastings-Kearney cut-off next year. Surveys were made two years ago.

Portland, Ore.—Clackamas Southern Ry. Co., with principal office in Portland, Ore., and capital stock of \$1,000,000, has been incorporated. The incorporators are: F. M. Swift, David Loring and A. E. Clark.

Pittsburg, Pa.—Western Allegheny R. R., T. Liegett, Jr., Chief Engineer, New Castle, Pa., is stated to have made final surveys for the construction of a new line from Kaylor, Pa., to Reidsburg.

Bristol, Tenn.—Press reports quote J. H. McVee, Bristol, Tenn., General Manager of the Virginia & Southwestern R. R., as announcing that construction work on the Holston River R. R., the proposed trunk line through East Tennessee into the south West Virginia coal field, will be resumed at once. Work was suspended in 1907.

Artesia, Tex.—Mees Valley, Rio Grande & Mexico R. R. Co., has been organized and projects a line from Artesia, Tex., west to

Asherton, a new town in Blinn County, Tex. Later the line may be extended to become a connecting link between the Great Northern and the Sunset Route at Eagle Pass. A. M. McElwee, President of the Texas Seating Co., Fort Worth, Tex., is interested.

Roscoe, Tex.—Roscoe, Snyder & Pacific Ry., Martin Duxal, Chief Engineer, Roscoe, Tex., is extending its line about 20 miles northwest to Fluvanna. A considerable part of the grading has already been completed.

Pecos, Tex.—Advices from Pecos state that M. L. Swineheart, a promoter and railroad builder, of Chicago, Ill., has started location surveys for the Toyah Valley R. R., which is to start at Pecos and extend to Balmorhea, a distance of 35 miles.

Salt Lake City, Utah.—Oregon Short Line R. R., Wm. Ashton, Chief Engineer, Salt Lake City, Utah, is said to be planning to take up work of double tracking its line between this city and Ogden.

Roaring Fork, Va.—E. L. Gobble, C. E., Blackwood, Va., is making surveys for the Roaring Fork & Powell's River R. R., which proposes the construction of a road from Roaring Fork, Va., up Powell's River into the Wise County coal fields, seven miles into the heart of the Big Black Mountains, near the Kentucky-Virginia border. It is stated that construction work will be started as soon as surveys have been completed.

Glenray, Va.—The Glenray & Richmond R. R. has been incorporated with an authorized capital stock of \$20,000, and headquarters at Glenray, Va., and proposes to construct a line from a point near Alderson, Va., to Richmond. Frank M. Arnold, Clarion, Pa., and H. P. Anderson, Glenray, Va., are interested.

Madison, Wis.—State Railroad Commission of Wisconsin has granted Chicago, Milwaukee & St. Paul R. R. permission to issue \$150,000,000 of additional stock for the building of the Pacific Coast extension. Of this amount \$77,000,000 has already been expended.

Electric Railways.

Items Arranged Alphabetically by States.

Little Rock, Ark.—Central Arkansas Electric Ry. Co., is to open offices in Little Rock, preliminary to having surveys made for its projected line. The route lies south from Little Rock to a point about five miles south of Sheridan in Grant County, where it will divide, one branch running to Hot Springs, and one to Pine Bluff, Ark.

Siloam Springs, Ark.—The Western Surety & Investment Co., of Minneapolis, Minn., is promoting the construction of an interurban line from Joplin, Mo., entering Arkansas at Pearidge and passing through Bentonville, Siloam Springs, Springdale, Hinesville, War-eagle and Rogers. J. P. Paul, Siloam Springs, Ark., is reported to be interested in the project.

Berkeley, Cal.—The Southern Pacific Co. has been granted franchise for its electric railway system in this city.

Steamboat Springs, Colo.—Company has been organized to build an electric freight line from Steamboat Springs to Hahn's Peak. Work will be started in the spring, it is said. A 100-ft. high dam is to be built across the Elk River forming a reservoir for irrigation and power purposes. Dr. E. A. Hewitt, Denver, Colo., is Consulting Engineer and General Manager of the company.

Des Moines, Ia.—American Engineering Co., Terminal Bldg., Indianapolis, Ind., which has contract for surveying and construction of the Des Moines & Sioux City Interurban R. R., will, it is said, start surveying work about Jan. 1, so that construction work can be started in the spring. The line is to connect Des Moines and Sioux City.

Des Moines, Ia.—Des Moines & Council Bluffs Ry. Co. has been organized for the purpose of building a railway between Des Moines, Ia., and Council Bluffs. H. A. Smith, Des Moines, Ia., is Secretary.

Davenport, Ia.—Surveys are to be started at once under the direction of W. H. Kimball for the proposed electric railway from Davenport, Ia., to Albany, a distance of 32 miles. The Peoples Construction Co., J. W. Crowley, President, Davenport, Ia., is interested.

Des Moines, Ia.—Des Moines, Winterset & Creston Interurban Ry. Co., L. H. Hixson, Secretary, Iowa Loan & Trust Bldg., Des Moines, will, it is said, soon take steps to dispose of its bond issue for constructing the road.

Sioux City, Ia.—Sioux City Traction Co., E. L. Kirk, General Manager, Sioux City, Ia., is to be petitioned to extend its South Sioux City car line to the banks of Crystal Lake, about 1½ miles.

Salmon, Idaho.—Senator R. W. McBridge, Salmon, Idaho, is promoting a project for the construction of an electric railway from Salmon to Gilmore and on to Idaho Falls. The distance between the proposed terminals is 160 miles and it is estimated that the road can be built for \$1,500,000. It is proposed to construct a \$500,000 power plant on the Salmon River near Salmon to furnish power for the line.

Morris, Ill.—Franchise to build an electric railway in Morris has been applied for by Ernest Freeman, Chicago, Ill., President of the United Electric Co., which supplies Morris with electric power. He proposes to build north to Joliet and south to Dwight.

Jacksonville, Ill.—Springfield & Jacksonville Electric Ry. Co. has been incorporated with a capital stock of \$100,000, and proposes to build a line from Springfield to Jacksonville. The incorporators include: D. H. Sims, Latham, Ill., and C. R. Cronk, Chicago, Ill.

Indianapolis, Ind.—Indianapolis, Cloverdale & Vincennes Traction Co., recently incorporated with a capital stock of \$100,000, is stated to have secured all right of way for its proposed line, with the idea of commencing work early in January. As proposed the interurban line is 110 miles long, extending from Indianapolis through Mooresville and Cloverdale to Vincennes, Ind. Harry C. Sandusky, Indianapolis, Ind., is Chief Engineer.

Valparaiso, Ind.—City Council has granted Valparaiso, Gary & Hobart Electric Line franchise on a number of streets. The company also has a franchise in Gary, and its line will be built on a private right of way. James S. Hopkins, Chicago, Ill., is President and Blake A. Mapledoram, New York City, is Chief Engineer and General Manager.

Topeka, Kan.—R. C. Rawlings, Chanute, Kan., and C. E. Sutton, Lawrence, Kan., are reported to have joined interests for the construction of an interurban railway from Kansas City to Topeka, via Lawrence, and from Lawrence south to Coffeyville, passing through Baldwin, Ottawa, Garnett, Iola, Humboldt, Chanute, Thayer, Parsons, Cherryvale and Independence. The total mileage is 300 miles. It is stated that the road will be constructed under the supervision of the Interurban Construction Co., of which Charles E. Sutton, Lawrence, Kan., will be President.

Louisville, Ky.—Louisville & Eastern Traction Co., has been reorganized by a syndicate composed of Lawrence James, Samuel Culbertson and Sebastian Zorn, all of Louisville, and the construction of the extension from La Grange to Shelbyville will probably now be carried out.

South Haven, Mich.—Chicago, Benton Harbor & Grand Rapids R. R. Co. has been granted franchise here for building electric railroad through the city. When completed the road will start at Benton Harbor, pass through South Haven, and connect at Saugatuck with the Grand Rapids-Holland line. The franchise was granted to Joseph W. Hosmer, Wm. E. Dodson and Geo. S. Hannaford, all of Chicago, Ill.

Springfield, Mo.—Springfield Traction Co., Springfield, Mo., will probably commence work this spring on its proposed traction line from Carthage, Mo., to Springfield. Surveys for two proposed routes have already been made. The line will be from 45 to 55 miles long, depending on the route selected.

Cleveland, O.—Lake Shore Electric Ry. Co., Cleveland, O., is reported to be considering extending its Gibsonburg branch line from Gibsonburg to Helena, four miles distant.

Grove City, Pa.—Surveys for an electric railway between Slippery Rock and Grove City have been completed. Surveys have also been under way for an electric line from Grove City to Meadville, Pa. H. H. Long, Slippery Rock, Pa., James A. Jolliffe, Wheeling, W. Va., and S. L. McClure, Washington, Pa., are interested.

Sewers.

Items Arranged Alphabetically by States.

Pleasanton, Cal.—The Town Trustees are to be petitioned to call an election to vote on the matter of installing a sewer system. Local Chamber of Commerce is back of the project.

Oroville, Cal.—City Trustees are taking steps to raise funds for the construction of additional sewers.

Melrose, Cal.—Sanitary Board of District No. 1, M. R. McKenna, Chairman, has sold a \$30,000 bond issue for the construction of sewers and work on installing the sewers will be started at once.

Ocean Park, Cal.—City Trustees are considering improving the sewer system.

Wilmington, Del. Work is to be started at once under the direction of Alexander J. Taylor of the Street and Sewer Department, on the construction of the proposed new Shipley St. sewer. Sewer is to be constructed of reinforced concrete pipe, which the sewer department is now making. The sewer will vary in size from 2 to 4 ft.

Tallapoosa, Ga.—City is considering installing sewer system and water works.

Mount Pleasant, Ia.—City is considering installing sewer system.

Peoria, Ill.—Board of Local Improvements is preparing plans for a sewer system in that section of the city embraced in the 8th, most of the 6th and part of the 7th ward. The estimated cost is \$300,000.

Silvis, Ill.—H. G. Paddock, Consulting Engineer, Moline, Ill., has completed plans for sewers, water mains and stand pipe for this place. The estimated cost is \$31,000. Public hearing is to be held Dec. 30. Improvements call for the laying of 3 or 4 miles of 6 to 12-in. pipe sewer and a similar amount of water mains. The stand pipe, 112 ft. high, to cost \$10,000, is also included.

Whitehall, Ill.—City Council is to at once secure plans for construction of a sewer system.

Indianapolis, Ind.—B. H. Miller, City Engineer, has completed plans for sanitary sewer to complete the system in River Side Place. The sewer will cost about \$9,000 and will be made of 8 to 10-in. pipe. Plans are also being drawn for sanitary sewers in Highland and Nelson Streets.

Terre Haute, Ind.—City Engineer Schmidt has completed plans for the proposed sewer in 24th St. between Locust St. and 18th Ave.

Great Bend, Kan.—Meeting has been held to consider engineer's report on installing a sewer system.

Lindsborg, Kan.—H. A. Rowland, City Engineer, McPherson, Kan., is preparing plans and specifications for sanitary sewer system for this city.

Grand Rapids, Mich.—All bids received Dec. 17 for construction of Canal St. sewage pumping station were rejected. The lowest bid was from Vanderberg & Hurbert at \$7,998. Engineer's estimate was \$6,655. The work will be readvertised.

St. Paul, Minn.—Board of Public Works has approved plans for the construction of a sewer in Albemarle St., to cost \$5,929.

Missoula, Mont.—Committee of which Frank Keith is a member has been appointed to ascertain the best method of securing a sewer for the South Side.

Atkinson, Neb.—City may have plans made for installing a sewer system.

Williston, N. Dak.—City will probably soon call for bids for constructing a sewer system.

Canton, O.—J. A. Starrett, City Engineer, has been instructed to suggest plans for providing additional tanks at the sewage disposal plant and for installing a method like the septic system.

Wagoner, Okla.—Election is to be held on Jan. 15 to vote on issuing \$40,000 of bonds for installing sewer system.

Ardmore, Okla.—City is considering installing septic tanks for sewage disposal.

Okmulgee, Okla.—City Council is considering plans for expending \$100,000 for sanitary and storm sewers, water extensions and city hall.

Scottdale, Pa.—Plans have been completed for sewage disposal for this borough.

Danville, Pa.—Plans for sewage disposal plant for this borough are being revised.

Philadelphia, Pa.—Ordinance is before select council to appropriate \$500,000 for the construction of intercepting sewer.

Williamsport, Pa.—Petition is now being circulated to have storm sewer constructed in the bed of the old Good Mill Race.

Reading, Pa.—Board of Public Works will include in its estimate for the next year an item of \$45,000 for the construction of the Franklin St. sewer and an item of \$20,000 for the Lateral end and North Eastern Intercepting sewer, and an item of \$12,000 for the Rose Valley Creek sewer.

Park City (P. O., Knoxville), Tenn.—Bids are to be asked shortly on the construction of 4½ miles of sewer.

Hubbard City, Tex.—City is to take steps for the speedy installation of a sewer system and water works.

Toronto, Ont.—Provincial Board of Health has approved the plans of this city for a trunk sewer in connection with its sewage disposal system. This plans provide for emptying of the partial treated sewage in the lake in 20 ft. of water about 1,500 ft. from shore.

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WATER-WORKS EXTENSIONS.

Clinton, Okla.

Sealed bids will be received by the incorporated town of Clinton, Okla., for furnishing all tools, labor and material necessary for about 40 blocks extension to the distributing system of the Water-works, until 8 p. m., Tuesday, January 5, 1909.

All bids must be accompanied by a certified check approximately in amount of 5 per cent of the bid, made payable without reserve to the Town Treasurer, Clinton, Okla. Bids must be made on blanks furnished by the town, and must be addressed to Mayor V. F. Carleton, and must be plainly marked on the outside "Proposals for Water-works Extensions."

Plans and specifications are on file with and blanks can be obtained from J. L. O'Hearn, City Engineer, Clinton, Okla.

The town reserves the right to reject any or all bids, to waive defects and to accept any bid.

S. J. STORM, Town Clerk.

STREET PAVING.

Olympia, Washington.

Bids will be received by the City of Olympia, Wash., until 5 p. m., Feb. 1, 1909, for constructing about 6,000 sq. yds. of vitrified brick or creosoted wood block pavement. Work to begin May 1, 1909.

JAMES R. DERER, City Clerk.

IMPROVEMENTS TO WATER WORKS.

Connersville, Ind.

Notice is hereby given that the City of Connersville, Indiana, will on the 12th day of January, 1909, at 7:30 o'clock p. m., receive proposals for the construction and leasing to said city of certain improvements and additions to the City Water Works and water supply of said city, according to specifications on file in the City Engineer's office.

All proposals to be in the form of an offer to purchase real estate on which to construct pipe lines, pumping station and other things, and to lease all of such property to the city for a term of years, not less than ten (10) nor more than twenty-five (25), at an annual rental to be specified in proposal and providing for the right of said city to purchase said property and water supply at the end of term of years for a fixed price to be therein specified.

Such proposal shall be accompanied by plans and specifications showing style of structure and machinery to be erected specified, together with the contract or lease. The lessor to guarantee the maintenance of the source and supply of water.

Proposals to be accompanied by good bond, payable to said city in the penal sum of one hundred thousand dollars (\$100,000), conditioned that said lessor will complete said additions in accordance with terms of specifications and guarantee the maintenance of said source of water supply during term of lease.

The city reserves the right to hold any or all proposals open to acceptance until one is accepted according to the method prescribed by law.

JACOB S. CLOUDS,
City Clerk.

K. L. HANSON, Engr.

SLUICE GATE AND BRIDGE.

Monterey, Calif.

Sealed bids will be received by the clerk of the Board of Supervisors of the County of Monterey, at his office, until 10 o'clock a. m. of Monday, January 4, A. D. 1909, for a combined automatic sluice gate and highway bridge, on Elkhorn Slough, near Hudson's Landing, in Pajaro road district, in Monterey County, State of California.

Plans and specifications for this work are on file in the office of the said board, to which bidders are referred.

Each bid must be accompanied by a check, made payable to the chairman of the Board of Supervisors of Monterey County, California, and certified by some responsible banking house, in the sum of 10 per cent of the amount bid.

The board reserves the right to reject any or all bids.

(Seal.) T. P. JOY,
Clerk of the Board of Supervisors of the County of Monterey

WATER-WORKS AND ELECTRIC LIGHT FRANCHISE.

Leesburg, Florida.

Bids Wanted. Town of Leesburg, Fla., invites bids for water works and electric lighting plant. Contract of 5 years given, carrying with it 30-year franchise. Town will pay \$2,000 per year for public service. Bids opened January 5th, 1909, 7:30 p. m.

L. M. JOHNSON, Clerk.

DRAINAGE WORK.

Anoka, Minn.

Sealed bids will be received for the construction of Ditch No. 49, in Anoka County, by A. A. Caswell, County Auditor, at his office in the Court House, at Anoka, Minn., up to 11 a. m., Jan. 9th, 1909.

The work consists of constructing Ditch No. 49, of Anoka County, in accordance with report, plans and specifications on file in the office of the County Auditor.

The ditch will be from 2 feet to 6 feet wide on the bottom, from 10 feet to 19 feet on the top; the estimated number of cubic yards, 83,000, and the estimated cost, \$12,975. Work to be completed in the year 1909.

A certified check for 5% of that amount of the bid must accompany each bid.

The County of Anoka reserves the right to reject any or all bids.

A. A. CASWELL, County Auditor.

PAVING AND SEWERS.

Charleston, W. Va.

The Board of Affairs of the city of Charleston, West Virginia, will until 2:30 p. m. on Wednesday, the 6th day of January, 1909, receive sealed bids for grading, curbing, paving and sewerage certain portions of the streets and alleys of the city of Charleston.

The amount of work embraced in street paving approximates \$210,000, and in sewer work \$30,000. Bids will be received separately for street paving or sewer work.

Each bid on paving must be accompanied with a certified check in the sum of \$7,000, and each bid on sewer work in the sum of \$1,200, drawn upon some known responsible bank in the city of Charleston, W. Va., payable to the order of J. F. Bedell, City Treasurer.

The right is reserved to reject any and all bids and to let the work as a whole or in part.

For further information call on or address

W. A. HOGUE, City Engineer.

OFFICE OF THE CONSTRUCTING QUARTERMASTER, Fort Crook, Nebraska, December 21, 1908. Sealed proposals, in triplicate, will be received at this office until 11 o'clock a. m., January 21, 1909, and then opened, for constructing one brick stable and one brick bakery, and for installing plumbing, steam heating, electric wiring and electric lighting fixtures in buildings specified. Plans and specifications may be seen by intending bidders at the offices of the Chief Quartermaster, Department of Missouri, Omaha, Nebraska; Department of the Colorado, Denver, Colorado; Department of the Lakes, Chicago, Illinois; Department of Dakota, St. Paul, Minnesota, and at this office.

Necessary blank forms and full information furnished upon application here. A deposit of \$10.00 to insure return, is required before plans are sent upon individual application. The United States reserves the right to reject any or all bids, or to accept any part of a bid that may be advantageous to the Government. Envelopes containing proposals must be endorsed "Proposals for Public Buildings," etc., Fort Crook, Nebraska, and addressed to Capt. Joseph F. Gohn, Constructing Quartermaster.

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PAVING.

Pensacola, Florida.

Sealed proposals for the construction of concrete sidewalks in the City of Pensacola, Florida, will be received by the Board of Public Works at the City Hall up to 12 o'clock noon of the 18th day of January, A. D. 1909, proposals to be addressed to L. G. Aymard, Clerk of the Board of Public Works, and endorsed "Proposals for Construction of Concrete Sidewalks."

The work contemplated consists of approximately 634,000 square feet of concrete sidewalks. Specifications and blank form of proposal and contract can be obtained from the office of the City Engineer, Room No. 203, City Hall.

The right is reserved to reject any and all bids.

Each proposal is to be accompanied by a certified check for \$500.00, payable to the City of Pensacola.

LEE DANIELL,

Chairman Board of Public Works.

L. EARLE THORNTON, City Engineer.

STREET PAVING.

Mount Pleasant, Michigan.

Sealed proposals for the furnishing of material and the performance of the work necessary for the paving with either paving brick or asphalt macadam, and the construction of cement curb and gutter, on Main Street from the north line of Illinois Street to the south line of Broadway Street, and on Broadway Street from the east line of Washington Street to the west line of Franklin Street, in the City of Mount Pleasant, Michigan, according to the plans and specifications prepared by the City Engineer and now on file in the office of the City Clerk. A copy of said specifications will be furnished on application to City Clerk, that each bid for said pavement, curb and gutter shall be accompanied with a certified check of at least 5 per cent of the bid, as a guarantee that said bidder will enter into a contract and furnish sufficient bonds as required by council in case the contract is awarded said bidder. Said certified check to be made payable to the City Treasurer.

Said proposals to be deposited with the City Clerk of said city on or before Monday, the 4th day of January, 1909, at 8 o'clock p. m., to be opened and publicly read by the Street Committee at that time.

All bidders shall have placed with the City Clerk at the time said bids are to be opened, good and sufficient samples of the respective materials to be used in the construction of said pavement, should their bid be accepted.

Said council reserves the right to reject any and all bids.

AUGUSTUS BORDEN, City Clerk.

STEEL OR CONCRETE BRIDGE.

Salt Lake City, Utah.

Sealed proposals will be received at this office until 8 o'clock p. m., January 8, 1909, for the work of constructing a steel or concrete highway bridge across the Jordan River at North Temple St.

Instructions to bidders, together with specifications and forms for contract and bond, can be obtained upon application at the office of the Board of Public Works or City Engineer.

The right is reserved to reject any and all bids.

By order of the Board of Public Works.

H. J. McMILLAN, Chairman.

LOUIS C. KELSEY, City Engineer.

PROPOSALS FOR CONSTRUCTION OF barracks and quarters, and plumbing and heating and electric wiring same. War Department, office of the Constructing Quartermaster, New London, Conn., November 28, 1908. Sealed proposals for constructing one double barrack, one single barrack, two field officers' quarters, one four-set officers' quarters, two lieutenants' quarters, three double non-commissioned officers' quarters, and one double firemen's quarters, at Fort Terry (Plum Island), New York, and two double barracks, two field officers' quarters, four lieutenants' quarters, two double non-commissioned officers' quarters, and two double firemen's quarters, at Fort H. G. Wright (Fisher's Island), New York, and for plumbing, electric wiring and installing heating plants in same will be received here until 10 a. m., Feb. 10, 1909, and then opened. Proposals are desired for brick construction of all buildings and for reinforced concrete construction on bidders' plans of barracks and non-commissioned officers' and firemen's quarters. Information furnished on application. Envelopes containing proposals should be endorsed: "Proposals for Public Buildings," and addressed: "R. M. Schofield, Major, Q. M., Constructing Quartermaster, New London, Conn."

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Wide and quick publication of work to be contracted means wide competition and prompt and careful bidding and these mean to the owner reliable work at the lowest cost. A trial proposal advertisement in ENGINEERING-CONTRACTING has convinced officials of other cities of the truth of these assertions. A trial advertisement will convince you. It will cost only \$2.40 an inch.

This is a small sum to risk on a chance merely of securing wide competition, but we would not ask you to risk even so small a sum were we not convinced from results given to others that the chance is no chance, but a certainty. Will you not demonstrate the fact to yourself by a trial "Proposal" in our columns?

ENGINEERING-CONTRACTING, 355 Dearborn Street. CHICAGO

If you wish catalogs of the leading manufacturers send us a postal card giving your address and business, and the list numbers, as shown below, of articles of which you want catalogs.

This will save you the trouble of writing a large number of letters. Should you later on have correspondence direct with the manufacturers, we shall appreciate it if you will state in your letters that you are indebted to this paper for the introduction. Such a statement will be mutually beneficial.

- [illegible]

The above is only a partial list of the headings in our Card Index. No matter what you want, **TELL US** and we will put you in prompt communication with the leading manufacturers, dealers or contractors.

IN WRITING to our Advertisers for CATALOGS or PRICES Please mention ENGINEERING-CONTRACTING

15 Mins. in Hot Paint Gives Life of 15 Yrs.

This photograph shows railroad ties of southern pine that were immersed 15 minutes in hot paint made by this company. After nine years service the ties are as sound as the day they were treated, which means that, at worst, they will have a life of not less



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The Terebo-Proof Paint Company
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SARCO

REGISTERED TRADE MARK

Solves the Most Difficult Waterproofing Problems

In Connection With

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Bridges
Reservoirs
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Sarco Means Protection

ASK FOR BOOKLET 200

Standard Asphalt & Rubber CO.

First National Bank Bldg., CHICAGO

NEW YORK CITY

KANSAS CITY



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DO YOU belong to that discouraged looking line of men who file in and out of the big gate every day—who get the same *small* salary all year 'round, with no prospect of anything better?

If you do, glance over your shoulder when going through the gate tomorrow; note the failures behind you—the men past middle life who have given their best years to hard labor.

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... Structural Engineer
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Occupation.....

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CINCINNATI, OHIO

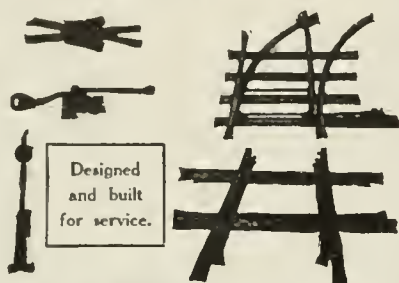
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Stands and Portable Track for all weights of
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We have the clamps for converting
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These drills are as good as new and will be sold at a reasonable price. Are for alternating current only. Apply to

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you to know THE VELTEN UNIVERSAL CRUSHER is the only machine which will reduce the hardest ROCK and GRAVEL, instantaneously, to any fineness according to your wishes. It can be adjusted without stopping your machinery; is very simple in construction; less power and less repairs are required for maintenance expense, and the least cost of any machine in the market. Prices range from \$30 up. Investigate and you will be pleased

Address the

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Contractor's Equipment

Model 20 Marion (New Aug. 1907) \$4,000
95-ton Bucyrus (used 10 mos.) 9,000
Little Giant Vulcan, Traction;

3 sets engines - - - 2,750
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20 other high-grade steam shovels:

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WANTED SITUATION Young man, technical graduate from first-class university, desires honorable position with engineer or construction company. Middle or north-west preferred. Address Box 74, care Engineering-Contracting, 355 Dearborn St., Chicago. 25-4t

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POSITION WANTED—By engineer with following qualifications: Total experience, 6 years, including field and office work, draughting, steel designing; 3 years resident engineer with railway and irrigation companies; university graduate; degree of B. Sc. Address Box 65, Engineering-Contracting, 355 Dearborn St., Chicago. 22-5t

WANTED—POSITION—Young man, 23, wants position with contracting company with idea of learning work. Do not care what salary is to start. Graduate civil engineer, with three years' experience in paving, sewer, water works and concrete construction. Any location. Address Box 76, care of Engineering-Contracting, 355 Dearborn St., Chicago. 26-2t

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WANTED—POSITION—Superintendent with ten years' practical experience in charge of construction, railroads, power plants, barge canal, foundations, pile and sheet driving, heavy concrete construction, rock and quarry work, up-to-date stone crushing, concrete mixing, steam shovel and derrick plants, open for engagement Jan. 1, 1909. First-class references from present employers. New York or Pennsylvania preferred. Age 32. Address Box 73, care of Engineering-Contracting, 355 Dearborn St., Chicago.

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WANTED—POSITION — Mechanical and construction engineer of initiative and executive ability with good business experience; buying, selling and shop work, desires to communicate with interested parties having any opening for a man of this description. Has been connected with some of the foremost mining and engineering organizations east and west.

Present salary \$5,000 per year; under contract until January first. Desires to locate permanently with suitable firm, investing with them in the enterprise if satisfactory. Address Box 66, care of Engineering-Contracting, 355 Dearborn St., Chicago. 22-5t

WANTED—POSITION with contractor, construction or manufacturing company, by young man 25 years, college education, 2 years mechanical and 1 year mining engineering. Experience, 2½ years special apprentice with railroad, 1 year inspector steel railway material, 1 year charge of power plant and construction. Can run instrument. Moderate salary, experience object, locate anywhere. William McCleary, School Lane, Germantown, Phila. 25-2t

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Also two 12-ton 36-inch gauge
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One No. 0 Chicago Mixer on Truck, with Gasoline Engine—absolutely new.

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NO course in civil engineering is complete without a thorough course in railroad location; for the methods used on railroad surveys are applicable to highway surveys, canal surveys, etc. A book that is admirably adapted for use as a text-book, or as a supplement to lectures, is Railroad Location Surveys and Estimates, by F. Lavis, M. Am. Soc. C. E. It has been adopted by several engineering colleges, and is generally conceded to be the clearest exposition of modern field methods yet published. It is written by an engineer of wide experience in railroad work.

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Reinforced Concrete

A Manual of Practice

By ERNEST McCULLOUGH, C. E.

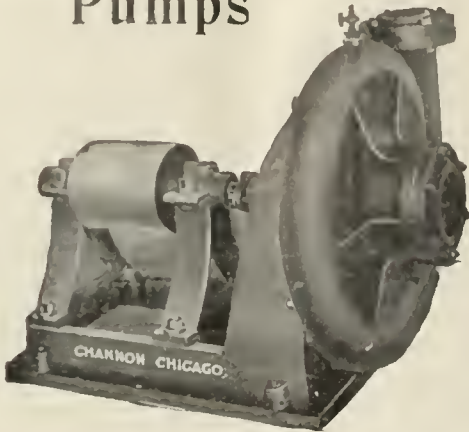
THIS book was written for the practical concrete worker—the man on the job—who has not the requirements of statics and the theories of the mathematician at his tongue's tip but who desires in plain words the fundamentals of correct design and the practice of sound and economical construction work.

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Direct-Connected Outfits of All Kinds

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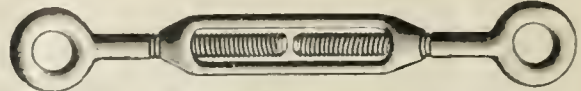
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An advertisement of the book will be found on another page.

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*or a given
amount of water
can be pumped with
25% less power
than with old style
centrifugal pumps.*

*It's a strong statement but we
have proved it hundreds of
times and we are ready to
prove it again that—*

On account of their being no sudden change of direction of the fluid when passing through the pump with a perfect cut-off near the outlet and the impeller being accurately machined to gauge on both sides and diameter and perfectly adjusted in the volute, it is impossible for the water to pass the impeller and churn in the casing in the

American Centrifugal Pump

and the entire mechanical action contributes directly to the highest possible efficiency, saving fully 25% of the expense of operation.

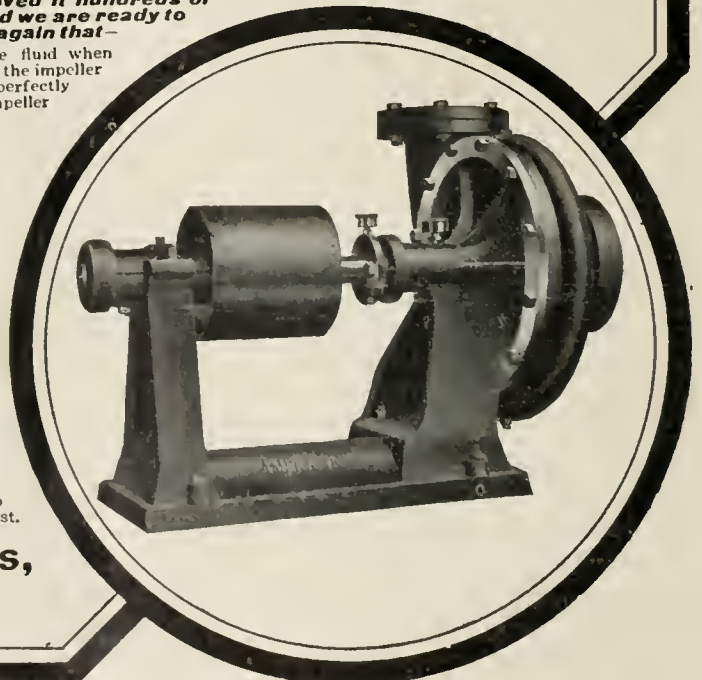
The unique design of the impeller enables the single stage pump to operate economically against high heads, saving the additional first cost and increased expense of operation of multiple stage pumps.

"American" Pumps are sold under a guaranty that they will give a mechanical efficiency of 60 to 80%, according to size, and that they will not use more power than is specified in our table of horse power required. There's a revelation in pump efficiency to engineers and contractors in our catalog and we mail it free on request.

The American Well Works,

General Office and Works, Aurora, Illinois, U. S. A.

Chicago Office: First Nat'l Bank Bldg.



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